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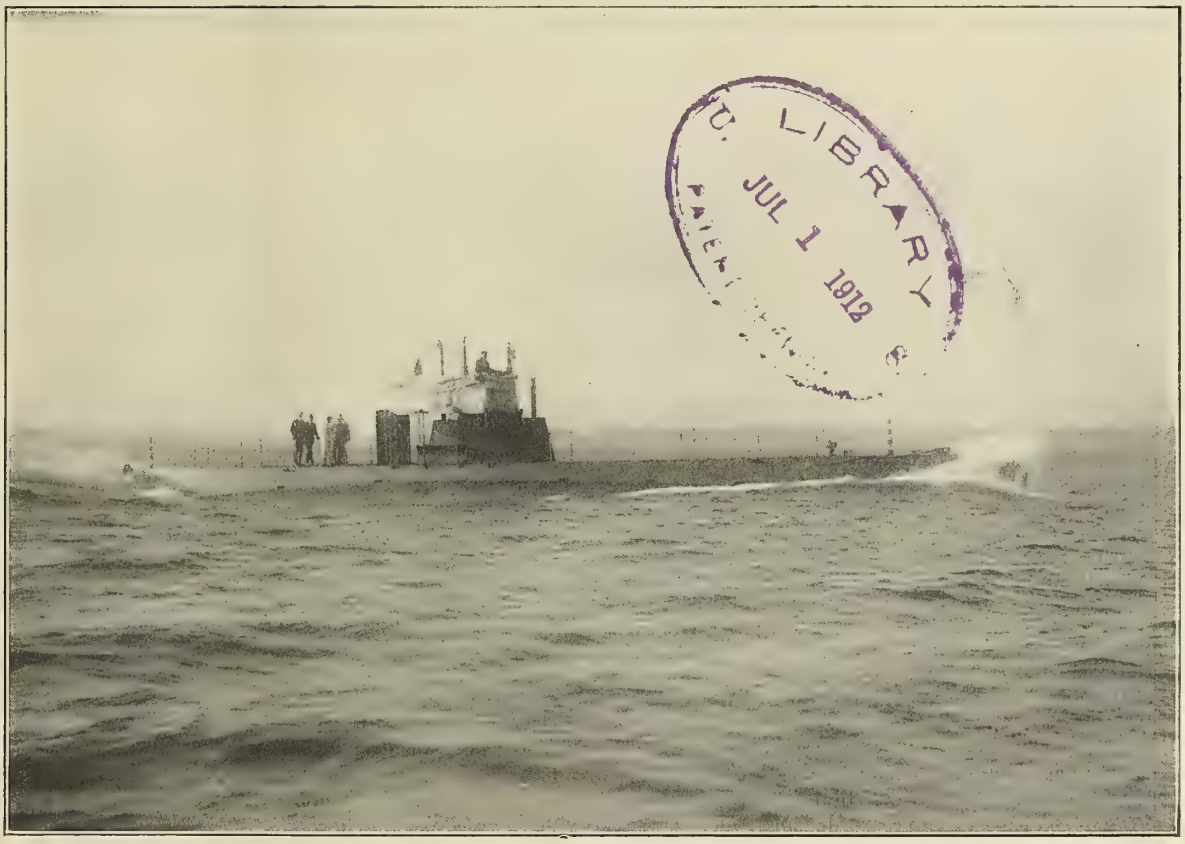
International Marine Engineering

JULY, 1912

Modern Submarine Boats for the United States Navy

The United States submarines *E*-1 and *E*-2 were at first called Nos. 24 and 25, signifying that they were the twenty-fourth and twenty-fifth submarines which had been ordered by the United States Government. Later they were given the picturesque names of *Skipjack* and *Sturgeon*, in conformity with the practice of the department then in vogue. Very recently the fish names have been withdrawn from all submarines, and in place of the *Adder, Grampus, Moccasin* and *Pike* we have *A*-1, *A*-2, *A*-3 and so on, until we come to the *Skipjack* and *Sturgeon*, which are now known as *E*-1 and *E*-2.


U. LIBRARY JUL 1 1912 PATENT

UNITED STATES SUBMARINE STURGEON AT A SPEED OF 13½ KNOTS

They are the only two of their class, and may be termed an intermediate type between their predecessors and later boats. The contract for these vessels was awarded to the Electric Boat Company, New London, Conn., on June 3, 1909. Their construction was completed in the spring of 1911, and during the latter part of that year their official trials were completed successfully. The dimensions of these vessels are:

Length	135 feet 3 inches.
Breadth	14 feet 11⅝ inches.
Draft in cruising condition	12 feet.
Surface displacement	284 tons.
Submerged displacement, including superstructure	367 tons.

The metacentric height when the boats are submerged is 13 inches.

The hulls may be described as spindle shaped, or bodies of revolution; that is, their cross sections are for the most part circular in shape, which is the form best calculated to withstand the pressure incident to great depth of submergence. That their hulls are exceedingly strong is best shown by the fact that these vessels were actually submerged to a depth of 200 feet. At this depth the pressure is about 100 pounds per square inch, and being applied from the exterior is a much more severe test than when applied from the interior. Any defect or weakness in the design of the hull would, under such conditions, immediately cause it to collapse, resulting in the loss of the boat. On the other hand, a badly-designed boat might possibly withstand an internal pressure of the same amount, for the reason that the stresses due to such internal pressure would merely tend to make the boat assume a form having circular sections, and thus distribute the stresses on the various members. The difference between a test made with external pressure and one made with internal pressure can be best understood by a particular case. If we had a strip of steel of the same thickness as the hull it would be possible to support a great weight thereby if this weight were hung from the

strip of steel, keeping its fibers in a state of tension. If, however, the same weight were placed upon one end of the strip of steel and the other end was placed upon the ground, the fibers would be in compression, and unless the strip of steel was kept perfectly straight it would bend and collapse. Exactly the same conditions apply to the hulls of submarine boats.

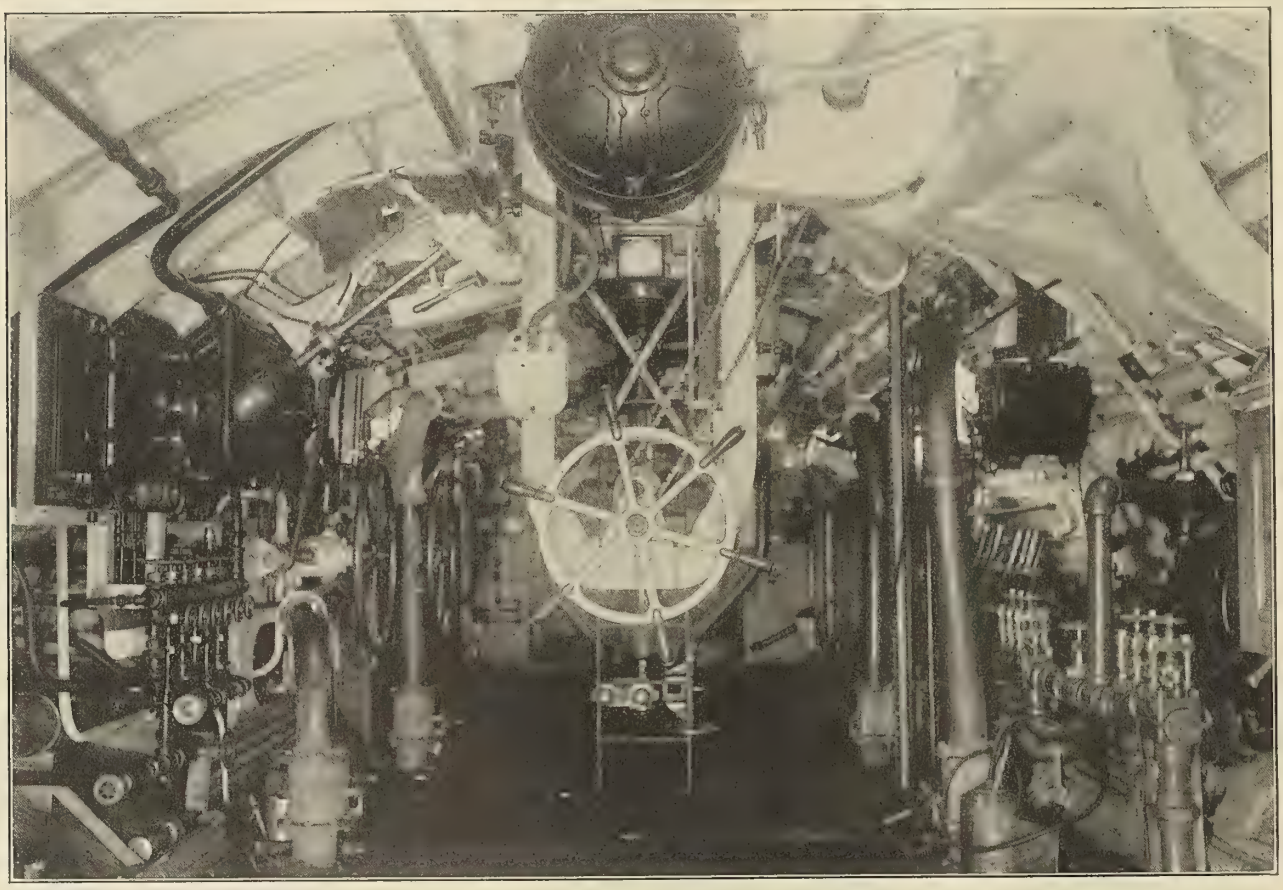
It may be interesting to our readers to know that all the submarines thus far acquired by the United States Government have been constructed to withstand safely a depth of submergence of 200 feet. So far as is known no other country has ever tested its submarines to so great a depth.

Two forms of motive power are supplied to these vessels, as is done to practically all other submarines in the world. For cruising on the surface and for traveling great distances the boats are propelled by oil engines. Two engines are fitted in each boat and they drive twin screws. Abaft the engines there is located on each shaft a large electric motor. These motors are used to propel the boat under water and receive their source of current from large storage batteries carried in tanks located above the inner bottom amidships. These batteries supply sufficient current to allow the boat to travel under water at high speed for one hour. By running more slowly it is possible for the boats to propel themselves completely submerged for twenty-four hours. In other words, the boats running at about 6 knots speed can travel fully 100 miles while remaining entirely beneath the surface of the water.

In addition to the main engines and motors a number of auxiliaries are provided, including air compressors, bilge pumps, clutches, ventilating fans and motors, periscopes, steering gear, air manifolds, water manifolds, together with numerous small motors and appliances for special purposes.

The sole armament of the submarine consists of its torpedoes. The bow of the boat is equipped with four torpedo tubes. The outboard ends of these tubes are closed by a bow cap, which is hemispherical in appearance and contains two apertures. When this bow cap is swiveled on an axial shaft the two apertures therein are brought in line with the torpedo tubes. As thus arranged two torpedoes may be fired simultaneously, or one immediately after the other. Then by means of a crank the bow cap is turned through 90 degrees and the other pair of tubes may be fired a few seconds later. In view of the great importance of the torpedo tubes and torpedoes, every effort is made to secure the perfect working of these parts.

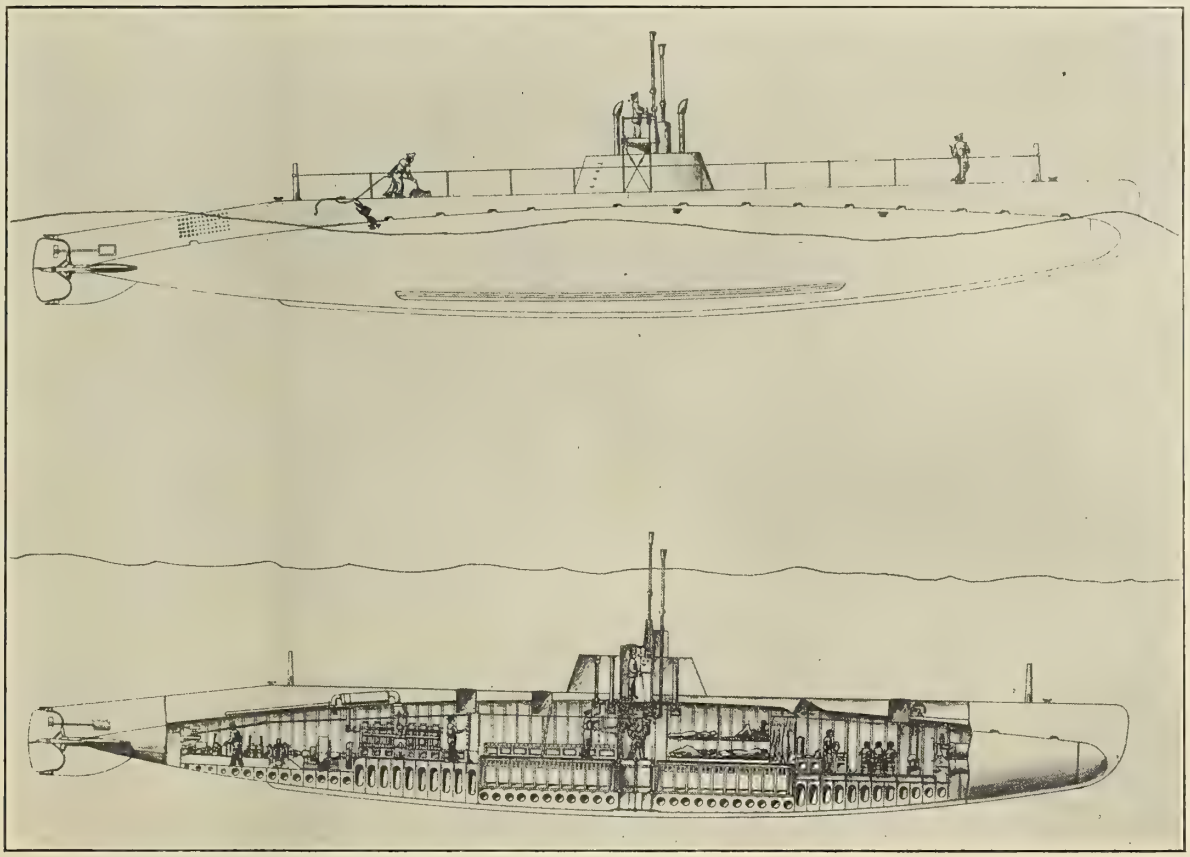
Having thus described the principal features of one of these boats it may be of interest now to see how they are operated. Probably the best way to illustrate the functions of all the various parts is to describe what would be done in case a submarine were to start out and go through the various performances of which it is capable.



CENTRAL COMPARTMENT, LOOKING FORWARD

Assume first that the boat is tied up alongside of a navy yard dock with the crew on board, and that telegraphic orders are received to proceed immediately to some scene of hostility. The first action of the commanding officer, assuming the boat to be ready to proceed to sea, would be to send a couple of men out on the superstructure deck and take in the lines which were cast off from shore. These lines would be coiled down under a hatch in the superstructure deck. The boat would be stripped of everything except perhaps a life line running around the superstructure deck. The oil engines would be started and the boat would proceed down the harbor and out to sea. While thus proceeding she would do much the same as any other surface vessel. All of her superstructure deck and a large portion of her hull would be exposed above the sur-

face of the water. The commanding officer would probably take his position on top of the conning tower on a light wooden grating forming the bridge, and steer by means of an electric push-button arrangement until the vessel is out at sea, when he would set the course by compass and turn the steering over to one of the quartermasters. The watches would be changed every four hours the same as on any other vessel, and there would be no very strenuous work for any one on board except the man in the conning tower and the two engineers on watch.



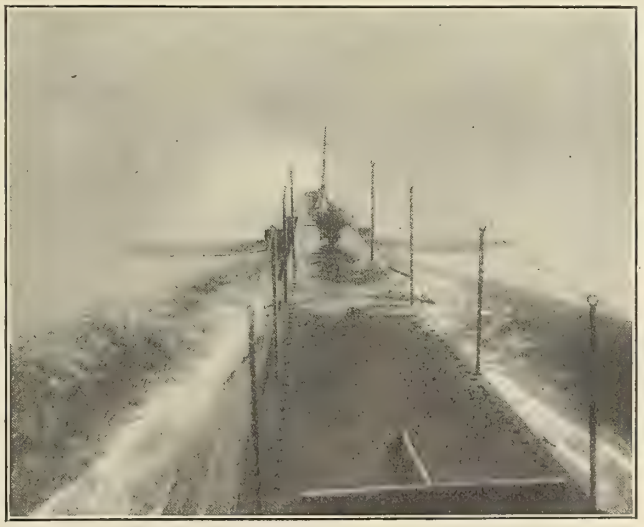
TYPICAL GENERAL ARRANGEMENT PLAN OF A MODERN SUBMARINE

Upon arrival in the vicinity of the scene of hostilities, or upon sighting a vessel suspected to be one of the enemy, the commanding officer would give the order, "Prepare to dive!" At this order the life line, if rigged, would be taken down from the superstructure deck and passed below. All hatches would be tightly closed and secured. The main engines would be stopped and the ventilators lowered and closed. All of this would take less than a minute.

After assuring himself that all openings to the outside atmosphere had been closed, the next order given by the commander would be to fill the main ballast tanks. At this order a man stationed at a group of levers near the middle of the boat would pull over several of the larger ones, the gurgle of water could be heard as it rushed through large openings in the bottom of the boat past the Kingston valves until it filled the main ballast tanks, holding about 30 tons of water. As these tanks are filled the boat would rapidly sink until her superstructure deck is awash and only her conning tower would be exposed to view. She would still, however, have considerable surface buoyancy.

The next operation is to destroy this buoyancy and at the same time preserve the trim of the boat. The commanding officer would probably take his station in the conning tower, looking out of the deadlights, forward and aft, to see the two ends of his boat, when he would direct water to be placed in the forward or after trimming tank as required until the trim is level, or to his satisfaction.

The third operation is to fill the auxiliary ballast tank. This is a tank containing several thousand pounds of water, and is located directly under the center of the boat. The admission of water to this tank will, therefore, not affect the trim but will serve to still further sink the boat. Water is admitted until only the top of the conning tower is out of the water.

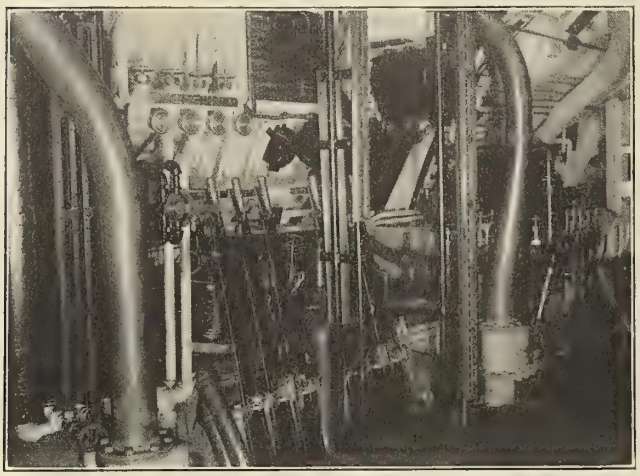


BOW RUDDERS EXTENDED

In other words, the boat at this time will have only 300 or 400 pounds of buoyancy, so that the admission of that amount of water would sink her below the surface, and she would

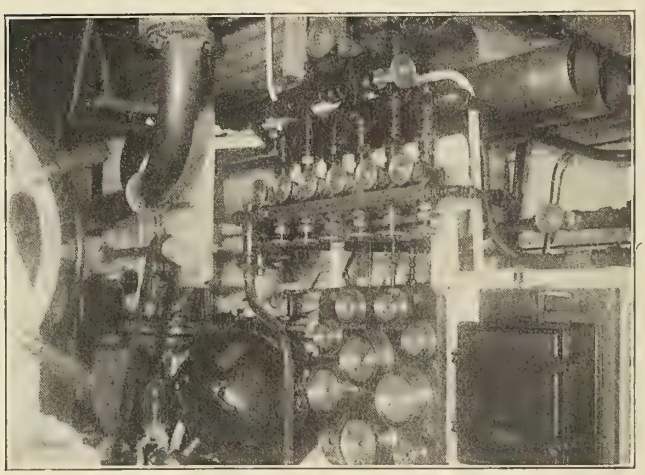
continue to descend unless the propellers were started or water blown out.

Having thus brought the boat to the desired trim, all of which would have taken only a few minutes, the commander rings a bell which displays a signal which the electricians understand as being an order to start the main motors. These motors are almost noiseless. The boat starts to forge ahead



KINGSTON VALVES

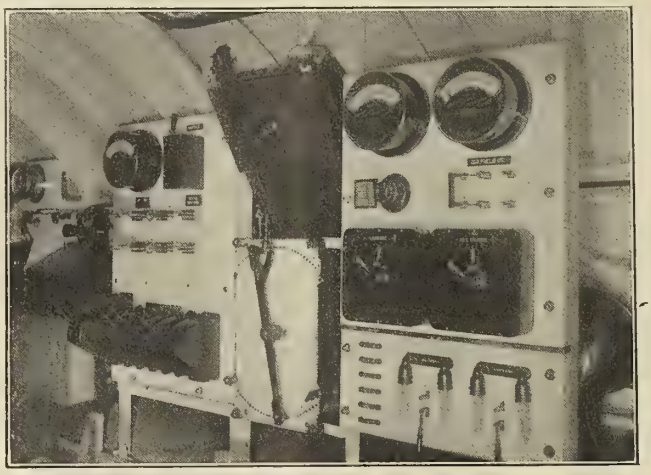
through the water. The diving rudder man is at the wheel, having in front of him a large gage, which indicates the depth at which the boat is running, and also a curved glass tube, or clinometer, which shows him whether her nose is pointing slightly up or slightly down. In the absence of any further orders from the commanding officer he would "keep her up"; that is to say, he would keep the boat running near the surface with the top of the conning tower exposed.



AIR CONTROL STATION

As soon as the commanding officer deems it time or advisable he gives the order "dive." At this order the man at the diving rudder turns his wheel; the diving rudder goes down, the boat takes a slight inclination forward, dives beneath the surface, and after having attained the desired depth is brought to the trim which will keep her running steadily at this depth. If the diving rudder man takes pride in his work he can keep the boat running for an hour continuously without changing the depth more than 1 foot. Even without exceptional skill or care it is possible for almost any diving rudder man to keep the boat running steadily without changing the depth more than 2 feet. The entire operation is exceedingly quiet. The motors themselves make no noise, so that one standing a few feet away from them would scarcely be aware that they were in operation.

When running entirely submerged the course is steered by means of a compass; there being two available for this purpose, one inside the conning tower and another just abaft the conning tower. For the purposes of taking observations the

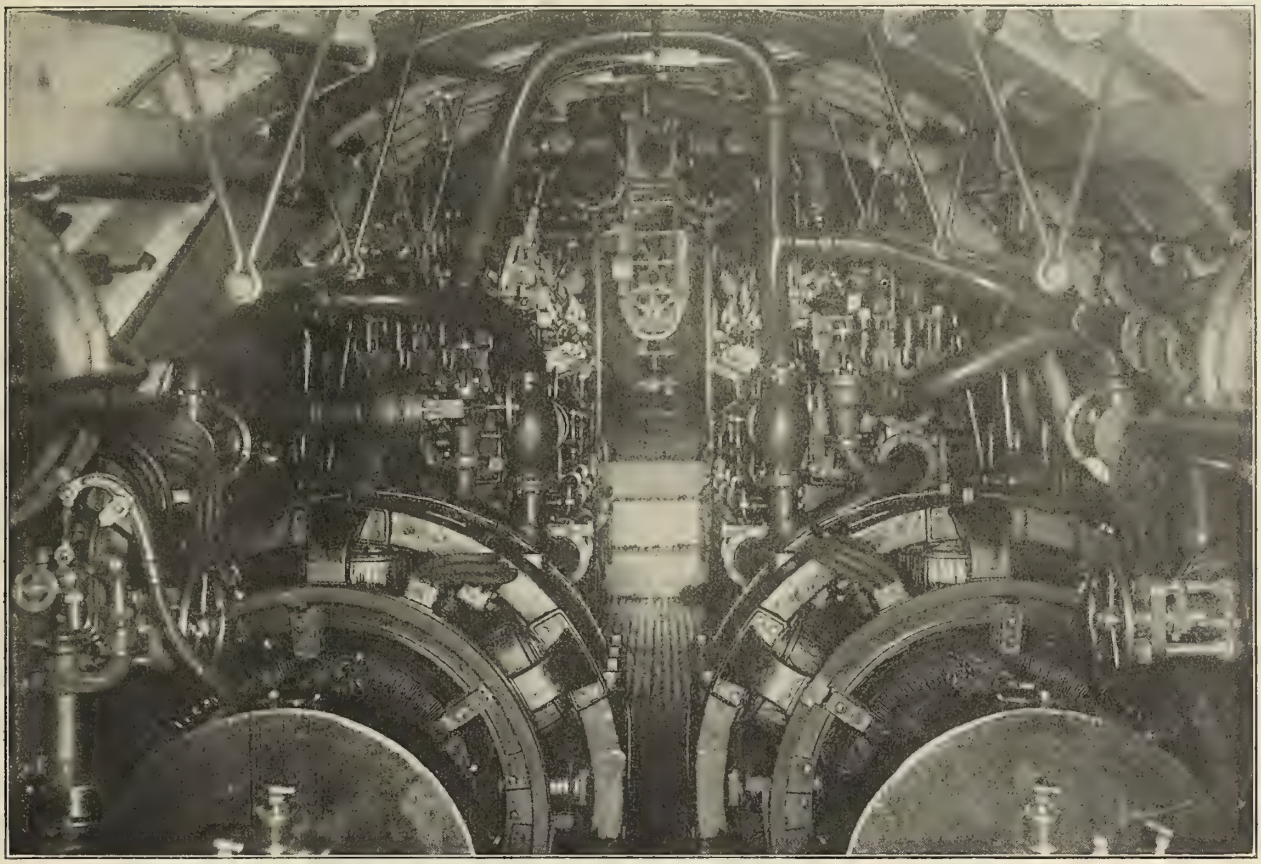


CONTROL PANEL FOR ONE MAIN MOTOR—AUXILIARY CONTROL PANEL

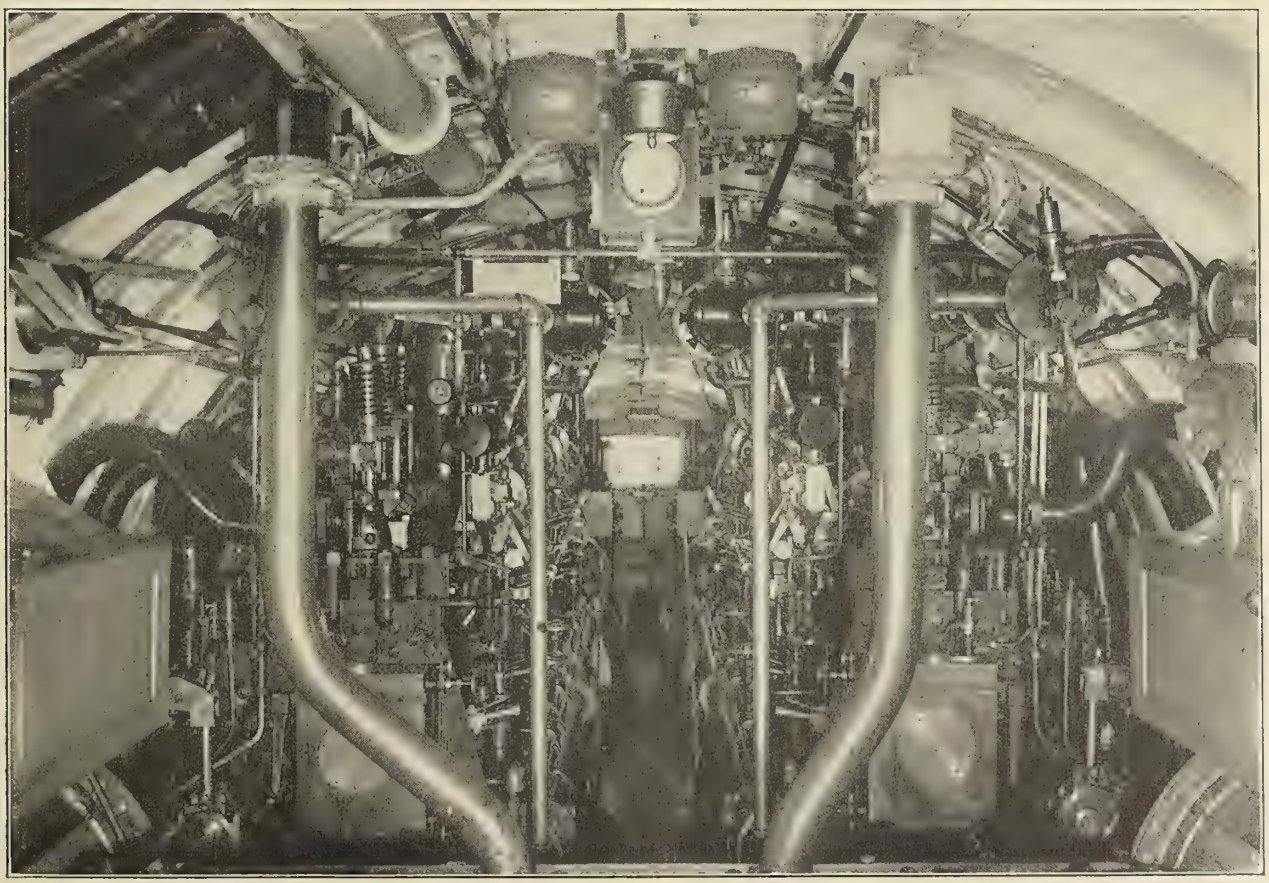
boats are fitted with periscopes. In *E*-1 and *E*-2 these periscopes are of the telescopic type, one of them being located forward of the conning tower, the other abaft the conning tower, and both having their eye-piece in the body of the boat. They may be turned so as to look in any direction. Objects as seen through the periscope are slightly magnified, this magnification being used to overcome what may be termed an optical illusion, the usual observer having the impression that objects when seen at their natural size through a periscope appear smaller than when viewed with the naked eye. These periscopes may be rotated so as to obtain a view in all directions and have a field of vision embracing 35 degrees.

Assuming that while thus running submerged the commanding officer sights the enemy's battleship, he would probably run directly toward her, taking an occasional glimpse through his periscope, and then dipping the periscope completely under until he had arrived at a point where he considered a torpedo hit as certain. With the present type of torpedoes, and the present size of battleships, any range less than 2,000 yards, or 1 mile, is such as to be now considered a practical certainty. A few years ago, with the older types of torpedoes, probably 1,000 yards was the greatest range that could have been considered certain. If, however, the battleship was running too fast, or there appeared a possibility of getting closer than 2,000, or even 1,000, yards, the commander of the submarine would probably keep on until he came so close that he would be doubly sure of making a hit.

In the meantime, while directing the operation of the boat, he would be at the periscope, and have under his hand the firing lanyard, which at the proper moment would release the torpedo from the tube and send it speeding with its 200 pounds of high explosive toward the amidship portion of the enemy with the torpedo depth set at 20 feet. Probably a second, and even a third or fourth torpedo would follow the first at intervals of only a few seconds. With perfect torpedoes at this close range the almost certain results to follow this discharge would be three or four successive dull detonations, which could be felt by the hull of the submarine even at a distance of 1,000 yards from the battleship. Although these torpedoes would explode against the battleship's side so far below the surface of the water a huge amount of water would



ENGINE ROOM, LOOKING FORWARD



ENGINE ROOM, LOOKING AFT

be lifted after the report of each explosion, and would be followed probably, as has happened in the past, by the careening over and gradual sinking of the battleship. In any event, a ship so attacked by four torpedoes may safely be considered out of action during the remaining period of hostilities.

Having thus finished her destructive mission *E*-1 or *E*-2 would then come to the surface. This is accomplished by giving the order "blow the main ballast," at which the man stationed at the air manifold would open a valve; compressed air would rush through this valve into a pipe leading to the top of the main ballast tank, and expanding therein would force out all the water which it contained through a hole in the bottom of the ship. The boat would then quickly rise.

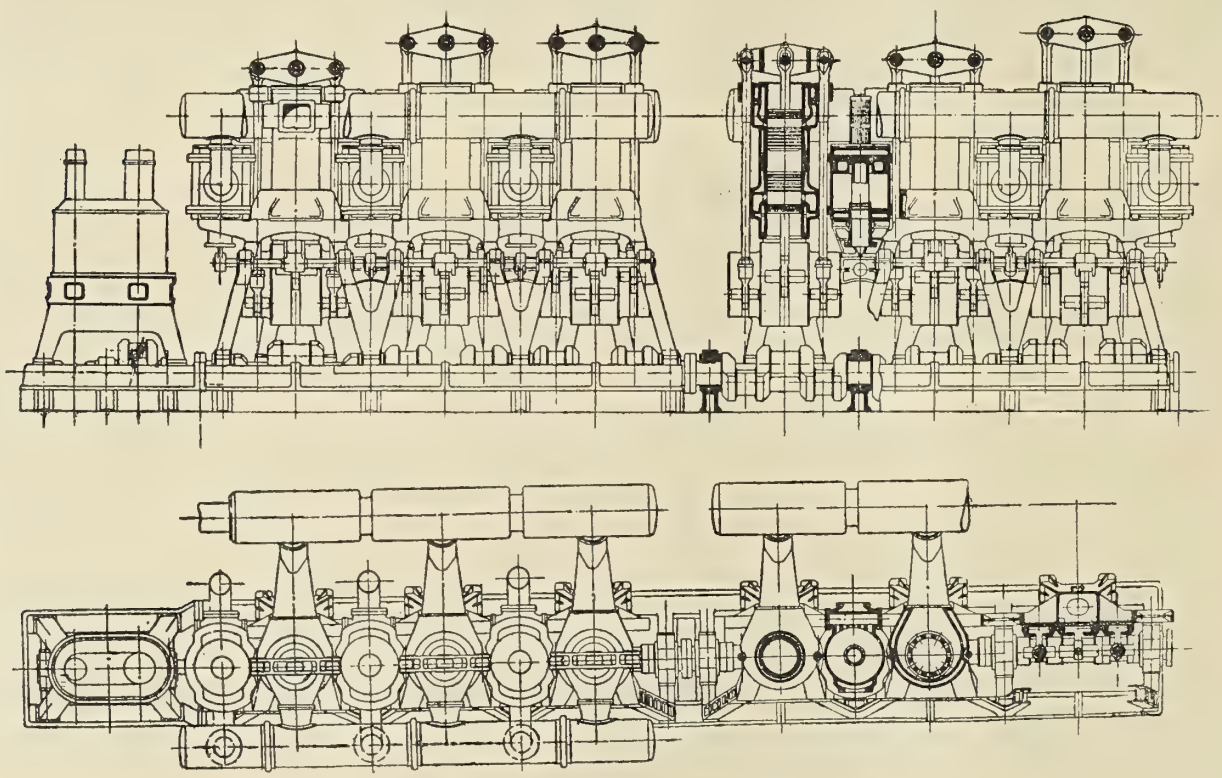
If it is expected that she might have to submerge again then the water in the trimming tanks and auxiliary tank would not be disturbed. On the other hand, if she is expected to undertake a long sea voyage, without likelihood of having to submerge, these latter tanks would also be blown, the conning tower and ventilators would be opened, the oil engines started up, and she would start on her return voyage at full speed, running on the surface.

The Application of the Junkers Oil Engine to Marine Work

At a recent meeting of the German Schiffbautechnische Gesellschaft in Berlin, Prof. Junkers read a paper on "Studies and Experimental Work for the Design of Improved Large Oil Motors." In the discussion of this paper the view was expressed that the crude oil motor would prove to be the marine engine of the future. This view already seems quite justified, since at present there are a large number of vessels being built in which the propelling machinery consists of crude oil motors. As evidence of the progressive attitude of engineering circles in Germany, it should be noted that a number of German shipyards have acquired licenses for constructing this type of machinery.

Recently the German Petroleum Company placed an order with Messrs. J. Frerichs & Company, Ltd., of Osterholz Scharmbeck & Einswarden (Oldenburg), for a twin-screw oil tank ship which is to be equipped with crude oil engines. The principal dimensions of the vessel are: Length between perpendiculars, 312 feet; beam, 44 feet; molded depth, 26.2 feet; total freight capacity, 4,000 tons. The vessel is of the full-deck type, designed to conform with the highest class of Bureau Veritas and the German Lloyds. It is to be built under the general supervision of both societies.

The propelling machinery will be installed aft. Forward of the machinery space is a tank extending for the full width of the ship, which is to contain the fuel oil. This tank extends up to the main deck. The main part of the hull is divided into ten oil-tight compartments for the cargo. Amidships is a chart house arranged on the bridge, providing accommodations for the captain and officers. Aft there is a poop deck, on which is a deck house containing the galley, officers' mess and the chief engineer's stateroom. Under the poop deck are accommodations for the engineers' assistants, other engineering personnel and cooks. Quarters for the seamen, boatswain, carpenter, etc., are also located aft. Gangways are provided, connecting the poop and bridge decks. Two steel masts give the vessel the rig of a schooner.



ARRANGEMENT OF JUNKERS MARINE OIL ENGINE FOR NAVAL VESSELS

The pipe mains for filling and emptying the tanks, together with the corresponding hatches, are arranged in accordance

with the latest practice for oil-tank vessels. Two vertical pumps of 3,600 tons daily capacity are located in the after cofferdam, which is designed as a pump house.

The propelling machinery consists of two reversible heavy oil marine engines, having an aggregate horsepower of approximately 1,500, designed to give the vessel a speed of 10 knots. The engines are to be built according to the patents granted to Prof. Junkers, the principal features of the Junkers type of oil engine being simple design, presence of only one operating valve and reliability of operation.

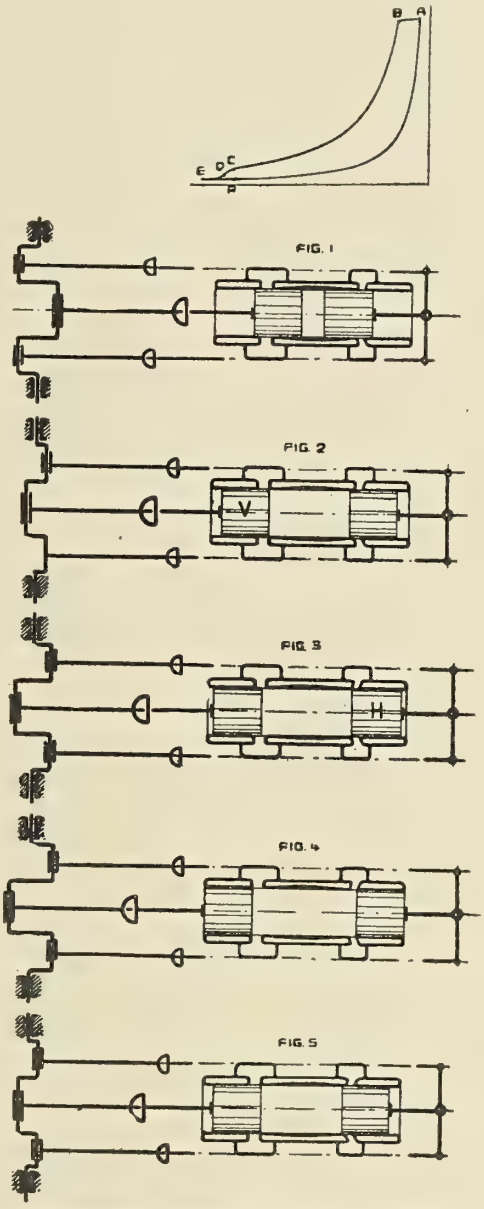
As the Junkers engine differs materially from the other types of internal-combustion engines for marine work, the following general description of the construction and method of operation of this engine is necessary to understand its special application for marine work: The early experimental work on this type of engine resulted in the development of stationary engines, which were principally horizontal engines. When the same principles were applied to marine work, the vertical type of engine was, of course, necessary. The general features of both the horizontal stationary engine and the vertical marine engine, however, are much the same, as can be seen from the following:

In the horizontal stationary engines there are two cylinders, placed one behind the other or in tandem form, each cylinder containing two pistons. For this arrangement there are three cranks placed at 180 degrees. The middle crank is connected to the two outer pistons and the two outside cranks, which are set 180 degrees in relation to the middle crank, are connected to the two inside pistons. This connection is made by transverse pieces and side rods, as will be seen from the drawings. The diagram on this page shows the general arrangement of this mechanism. The engine works on the two-cycle principle, and by means of the tandem arrangement of the cylinders the engine becomes a double-acting engine, in which every stroke is a working stroke. While the pair of pistons in one cylinder is executing an outward movement (working stroke) the pistons of the other cylinder execute an inward movement (compression stroke).

When the two pistons in one cylinder approach each other the injection of fuel commences. At the same time the two pistons in the other cylinder are separating, until at nearly the end of the stroke the expanded gases are driven out by the admission of scavenging air, which enters through a row of ports at one end of the cylinder, and, driving the spent gases away in front of itself, expels them at the other extreme end of the scavenging space. Complicated governing mechanism and scavenging valves are thus obviated, since the opening and closing of the ports is accomplished by the movement of the working pistons. Since the expansion of the gases takes place between two pistons, which move in opposite directions in the same cylinder, cylinder covers and stuffing boxes are dispensed with.

The action of the Junkers engine may be clearly understood from the diagram on this page, in which for the sake of simplicity only one cylinder is shown, whereas in practice there are two cylinders, one behind the other, or in tandem arrangement.

Fig. 1 shows the inmost position of the pistons. The combustion space between the pistons, immediately after a compression stroke is filled with highly compressed and, consequently, highly heated air, so that at that time and during part of the ensuing outward stroke the fuel, which is injected by means of compressed air in a finely divided condition, ignites and burns under an almost constant pressure during the first part of the outward stroke, or during the part shown from *A* to *B* on the indicator diagram shown herewith. During the remainder of the outward stroke the products of combustion expand, as shown in the indicator diagram from *B* to *C*. At *C* the pistons have reached the position shown in Fig. 2, where the front piston *V* is about to open the ports in the cylinder wall through which the burnt gases exhaust to the atmosphere. Up to the position of the piston shown in Fig. 3, or that part of the indicator diagram shown from *C* to *D*, the pressure in the cylinder has been reduced approximately to that of the atmosphere, and in this position the rear piston *H* opens the ports at that end of the cylinder, admitting fresh air to the cylinder at low-pressure, which scavenges the cylinder of the remaining burnt gases. This action continues until the outer dead center position of the pistons, Fig. 4, has been passed and the pistons have reached about the positions shown in



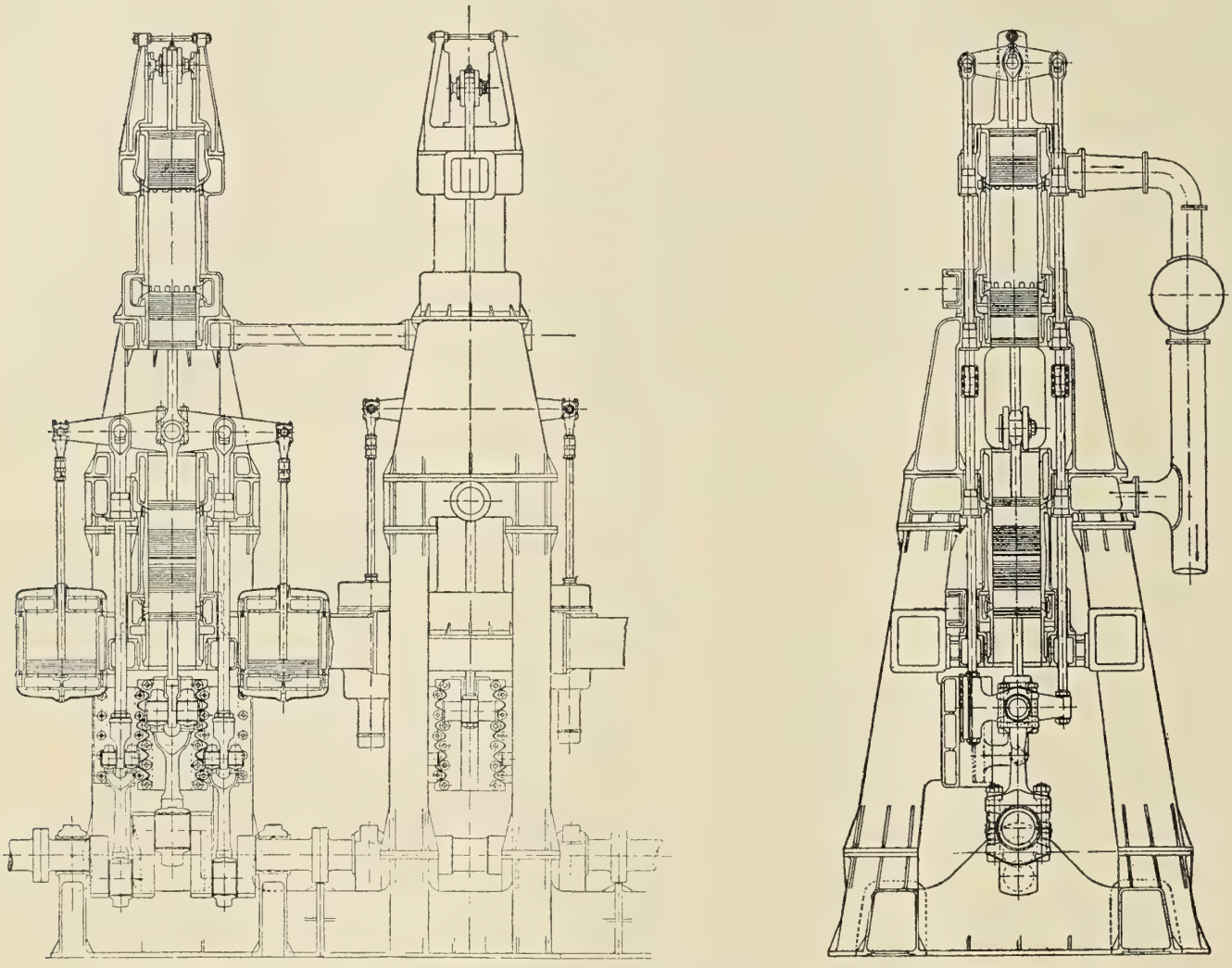
EXPLANATORY DIAGRAM OF JUNKERS ENGINE

Fig. 5, in which the pistons on the return to the inner dead center have closed their respective ports. This is shown on the indicator diagram by the part from *D* to *E* and to *F*. At the point *F* the cylinder is filled with fresh air, and from this point, as the pistons approach each other up to the inner dead center in Fig. 1, the contents of the cylinder are compressed. This part of the stroke is shown on the indicator diagram from *F* to *A*. The air which is thus compressed in the cylinder becomes heated to such an extent that the fuel which is injected at or shortly before the point *A* is reached ignites immediately, whereupon the working stroke is repeated.

The details of construction of the type of this engine which

is used for marine work are shown on pages 262 and 264. The scavenging pumps and compressors (in this case four-stage) necessary for the production of the scavenging and fuel spray air are arranged symmetrically with respect to the cylinder axis. They are actuated from the transverse bar attached to the middle pair of pistons. This arrangement makes the terline of the engine, neglecting the error due to the obliquity of the connecting rod. Moreover, the main bearings are relieved from their loads, due to the interlocking of the forces in the driving elements.

In the Junkers engine the cylinders are simple castings. They have no forces to transmit and are free to expand. The



GENERAL DESIGN OF JUNKERS ENGINE FOR MERCHANT VESSELS

weights of the reciprocating parts of the inner and outer power transmitting devices equal, and, further, affords good control and accessibility as well as a good distribution of scavenging air, small mechanical losses and simple, substantial and inexpensive production and erection.

Each cylinder where the diameter is large has two fuel spray valves and one compressed air starting valve. The fuel injection is so designed as to give the fuel oil a close contact

INDICATOR DIAGRAMS FROM 200-HORSEPOWER ENGINE

over a large surface with the combustion air in the dead center position and during part of the working stroke.

It is claimed that this type of engine offers a decided advantage for balancing the moving parts and the action of the forces as compared with usual engines of the Diesel type, inasmuch as the free forces are completely balanced in the cen-

side rods which take up the acting forces are made of forged material. The cylinders have no covers, which, as is well known, constitute a constant source of trouble in oil engines. One side of the pistons is always in contact with the atmosphere, and the pistons are always in contact with well-cooled cylinder parts which are not touched by the products of combustion. In this way efficient lubrication of the pistons can be obtained.

By the division of stroke, which is accomplished in this engine by the use of two pistons moving in opposite directions, it is possible to obtain a relatively small piston speed at a high rate of revolution. On account of the long stroke in this engine the ratio of surface exposed to the volume of the combustion space is comparatively small, and so the quantity of heat transmitted to the cylinder walls during the combustion in the first part of the stroke is much smaller than in other types of Diesel engines. This advantageous ratio of surface to volume of combustion chamber also means that with a given compression space the compressed air is less cooled towards the end of the compression and thus a steeper rise of the compression curve is obtained, which insures the necessary ignition temperature even at low rates of revolution. The inventor

of this engine claims that this fact is of great importance in running with heavy fuel and especially for the decrease of revolutions in marine work.

The scavenging arrangements in this engine also improve the operation of the engine, since in this class complete scavenging is thoroughly and easily accomplished. It is also claimed that since the charge of air drawn in does not become heated until compressed, a larger indicator diagram with a higher mean effective pressure and greater specific output are obtained in this design than is possible in the usual type of Diesel engine, since a colder air charge is obtained.

The general design of the Junkers marine engine for mercantile marine work is shown on page 264. The tandem arrangement is used here, since there is usually little difficulty in obtaining the necessary height in the engine room. A solid sub-structure overcomes the action of couple forces.

In the adaptation of this type of engine for warships the horizontal tandem arrangement, such as is used for stationary engines, offers distinct advantages from a constructive, shipbuilding and military standpoint, but if the designer is forced to use the vertical type of engine the conditions attending the tandem arrangement must be forfeited and a single cylinder arrangement adopted, as shown on page 262.

For engines designed for warships, Prof. Junkers has applied a special method of increasing the output, which consists of throttling the exhaust gases in the exhaust mains simultaneously with supplying a greater weight of air at a proportionately higher initial pressure by means of larger scavenging pumps. In this way a larger amount of fuel can be burned. Two diagrams are shown superposed (page 264) which were taken from a 200-horsepower experimental engine, in which the smaller was taken at normal load and the larger at 50 percent overload. As a warship is seldom required to run at full power except for short periods of time, the application of a suitable margin of overload in combination with the Junkers engine is of considerable advantage. In the merchant marine, however, conditions are just the opposite, as the vessel usually has to run continuously under full power and maneuvering is required only on entering or leaving a harbor.

On the oil tank vessel which is under construction at Messrs. J. Frerichs' Company's shipyard, the exhaust gases from the engines are carried out through a funnel. An auxiliary boiler is installed for heating purposes and the operation of the auxiliary machinery.

Launch of a Steel Screw Steamer at Stockton-on-Tees

On March 18, Messrs. Ropner & Sons, Ltd., Stockton-on-Tees, launched from their shipbuilding yard a steel screw steamer of the following dimensions, viz.:

Length	392 feet 6 inches.
Breadth	56 feet.
Depth	26 feet 9 inches.

The vessel will be classed 100 A1 at Lloyd's, having main deck, poop, long bridge and forecastle. Accommodation for the captain, officers and engineers is in houses on the bridge deck, with the crew in the forecastle. The vessel has a double bottom for water ballast on the celullar principle, and fore and after peaks. The appliances for loading and discharging cargoes expeditiously are very complete, and include ten steam winches, double derricks to each hatch, steam being supplied by a large donkey boiler, working at 100 pounds pressure per square inch. The engines will be of the triple-expansion type by Messrs. Blair & Company, Ltd., Stockton-on-Tees, of about 2,450 indicated horsepower, having three steel boilers, 14 feet 9 inches by 11 feet, working at 180 pounds pressure of steam.

A Canadian Liner

Scott's Shipbuilding & Engineering Company, Ltd., Greenock, launched in March the steel twin-screw steamer *Letitia,* built to the order of the Donaldson Line (Donaldson Bros., Glasgow), for their service between the Clyde and Canada. The *Letitia* is handsomely modeled. Her pricinpal dimensions are: Length between perpendiculars, 470 feet; breadth (molded), 56 feet 8 inches; depth (molded), 39 feet 6 inches to the shelter deck, above which are fitted poop, bridge, forecastle and boat decks.

The vessel has been designed for the emigrant trade, and takes the highest class at Lloyd's. The accommodation for second class passengers is fitted on the bridge. Shelter and upper-deck staterooms are provided for over 300 passengers of this class. The dining saloon, music room, writing room and smoke room are handsomely paneled in polished hardwood and very comfortably furnished. The galley and pantry arrangements are very extensive.

Accommodation is fitted on the shelter, upper and main decks for 600 third class passengers, principally in two and four-berth staterooms. Separate dining saloons and recreation rooms are fitted for this class, and a special feature has been made of their lavatory accommodation, which includes baths and wash basins, supplied with both hot and cold water.

While primarily intended for passenger trade the *Letitia* will carry a large cargo. There are five holds, served by ten derricks and ten steam winches. The steering gear is of the Wilson & Pirrie type, controlled by a telemotor. An extensive installation of electric light has been provided, and electric fans and bells are fitted throughout. Refrigerating chambers are provided for the ship's provisions and cargo, the plant being on the CO_2 system. A system of wireless telegraphy will also be installed.

The machinery, constructed by the builders, consists of two sets of triple-expansion engines. The propelling machinery has been built to Board of Trade and Lloyd's special survey. Six single-ended boilers, each having three Morison suspension furnaces and working under natural draft, supply steam to two sets of three-cylinder, triple-expansion engines, driving two screws. The high-pressure cylinder is 26 inches diameter, the intermediate 43½ inches diameter and the low-pressure 72½ inches diameter—all of 48 inches stroke. Piston valves control the steam to the high-pressure cylinders. Andrews' valves are fitted to the medium-pressure cylinders, and double ported slides to the low-pressure cylinders. The columns and bedplates are of substantial box section.

The condensers, circular in form, are carried on seatings from the tank top, and are supported by brackets from the backs of high-pressure and medium-pressure columns. Ample cooling surface is provided to maintain high vacua. Working in conjunction with the condensers are air pumps of the Edwards design. Independent centrifugal pumps supply the necessary cooling water.

A steam reversing engine of the all-round type and a steam turning engine are fitted to each main engine. The thrust and propeller shafting is of forged steel, the propellers are about 17 feet diameter and of the built type, the bosses being of cast iron and blades of bronze. There is an auxiliary condenser and a full equipment of auxiliary machinery to ensure the safe and economical working of the vessel and the comfort of passengers. For the disposal of ashes from the boilers two of Crompton's silent ash hoists, with the necessary chutes, have been installed. Duplicate sets of electric generating machinery supply current for the lighting of the vessel and power for cabin and saloon ventilating fans, etc.

Alaska Steamship Company's New Steamship Cordova

The steel screw steamship *Cordova,* built by the Harlan & Hollingsworth Corporation, of Wilmington, Del., for the Alaska Steamship Company, of Seattle, Wash., was constructed for passenger and freight service. She is 251 feet long aver all, 243 feet 3 inches between perpendiculars, 41 feet beam, 20 feet depth to main deck, and 30 feet to bridge deck. The vessel is built of steel and equal to Lloyd's requirements. The double bottom is on the cellular system with floors on every frame. The framing above the tank is reinforced by web frames, beams are fitted to every frame, and the main deck is completely covered with steel. The pillars are of H-section, and are fitted with wood to prevent damaging the cargo.

The vessel has a forecastle, bridge and poop, the latter being a continuation of the bridge but at 2 feet less height. These

PASSENGER AND FREIGHT STEAMSHIP CORDOVA

erections cover 75 percent of vessel's entire length. Large watertight doors are fitted at the forward end of the bridge, so that freight may be stowed under the bridge and poop.

The double bottom is constructed for carrying oil fuel, fresh water being carried in the tank under the engines and in the after peak. The vessel is divided transversely by four watertight bulkheads; she has two holds, served by two large hatches, 28 feet by 14 feet, on the main deck and one on the poop deck, the former strongly constructed and pillared so that heavy ore may be carried on top their covers.

The vessel is rigged as a two-masted schooner, the masts being of steel. Each mast carries two booms, each of which is capable of lifting 7 tons, also one boom designed and rigged for 20-ton lifts. These booms are of wood and stepped on a platform attached to the mast. The foremast carries a cross-yard and square sail, also a leg-o'-mutton sail, and the mainmast is rigged with storm sail. The mast and boom rigging is exceptionally heavy, all shrouds, stays and cargo running gear being steel wire with blocks of Boston and Lockport make in steel shells. Chain lashings with turnbuckles and slip hooks are provided in the forward well, so the vessel may carry a deck load of lumber if required.

Two powerful winches are fitted at each mast; they are of the vertical type, as manufactured by the Union Iron Works Company, of San Francisco.

The vessel is fitted with a steam windlass, steam warping capstan and steam steering engine, all of Hyde type. The steering engine operates a pinion through a friction device which absorbs all shocks, the pinion meshes directly with a geared quadrant on the rudder stock. The hand-steering gear operates the quadrant in a similar manner. A powerful towing engine is located in a house on the poop deck. This machine is of the Shaw-Speigle type, built by the American Engineering Company, better known as Williamson Bros.

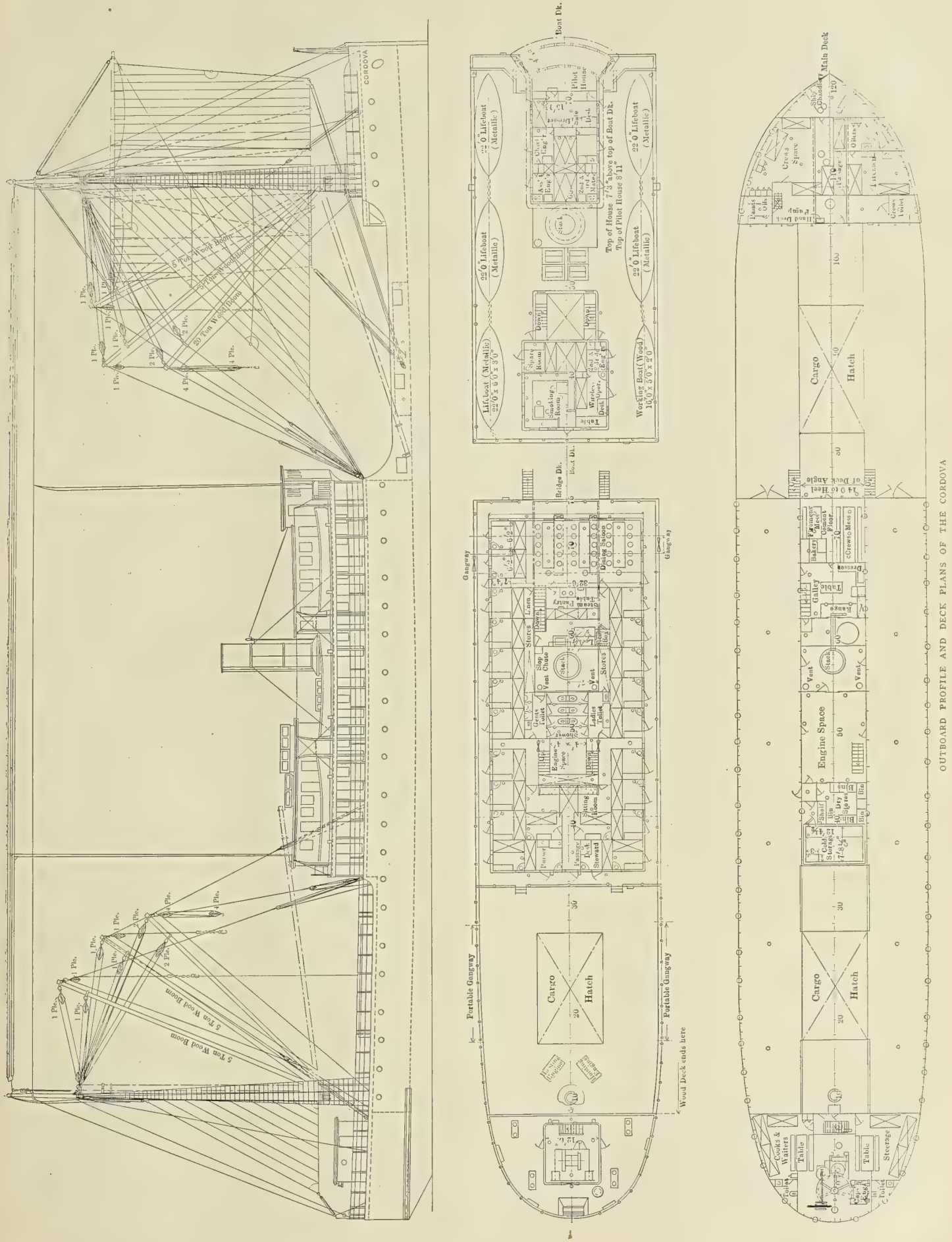
The crew are housed in the forecastle, the steerage and waiters are in the after end of the poop, metal beds and lockers being provided for their use. The galley, messroom, storerooms and cold-storage rooms are in the center house forward and abaft the machinery space below the bridge deck. A 1-ton refrigerating plant of Vulcan Iron Works make is installed for provisions and supplying ice water.

The passenger accommodation is in a house built on the bridge deck, at the forward end of which is the dining saloon, with the pantry abaft same, the latter having communication with the galley by a stairway and dumb waiter. All of the staterooms, with the exception of two, are outside rooms having outside doors; there are three berths in each room and all the furniture is of oak. Each stateroom is furnished with the usual wash bowl, mirror, toilet rack and steam radiator. The toilet rooms are located between the engine and boiler hatches, each being fitted with a shower bath, wash basins and tiled floor. These toilets are lighted and ventilated by overhead skylights. A small sitting room is provided for passengers on this deck, and a smoking room, finished in plain oak, is located on the boat deck, access to which is obtained by metal stairways. The bridge and poop decks are sheathed with heavy pine and form a splendid promenade for passengers.

The vessel is fitted with a wireless telegraph apparatus, the operator's room and office being located alongside the smoking room.

The officers' quarters are in the deck house at the forward end of the boat deck and immediately abaft the pilot house. These rooms are finished in oak. The captain's room is paneled in oak, and has a door opening into the pilot house. The pilot house is protected by a covered-in navigating bridge, on which the engine room telegraphs are placed; this navigating bridge is carried out to the sides of the ship, and is 2 feet above the boat deck, but level with the pilot house floor. A standard compass and searchlight are placed on top of the pilot house.

The vessel has one triple-expansion, surface-condensing engine, with cylinders 19 inches, 30 inches, 50 inches diameter and a stroke of 36 inches. The high-pressure and intermediate-pressure cylinders have piston valves, while the low-pressure cylinder has a double-ported slide valve. The condenser is built in with the frame of the engine. The valve gear is of the Stephenson link type. A steam reversing gear is installed and water circulation is provided for all bearings. The air pump and two bilge pumps are attached to the back of the condenser. The independent pumps, made by the Fairbanks-Morse Company, are the main and auxiliary feed pumps, donkey and fire


CORDOVA
5 Ton Wood Boom
20 Ton Wood Boom
5 Ton Wood Boom
5 Ton Wood Boom
Boat Dk.
Bridge Dk.
Main Deck
Pilot House
Top of House 7'3" above top of Boat Dk.
Top of Pilot House 8'11"
22'0" Lifeboat (Metallic)
Life Boat (Metallic) 22'0" x 6'0" x 3'0"
Working Boat (Wood) 16'0" x 5'0" x 2'0"
Gangway
Portable Gangway
Wood Deck ends here
Cargo
Hatch
Engine Space
Dining Saloon
Crew's Mess
Galley
Cooks & Waiters
Table
Steerage
OUTBOARD PROFILE AND DECK PLANS OF THE CORDOVA

pump, bilge and deck pump, sanitary, salt-water and fresh-water pumps. The circulating pump and engine were constructed by the builders of the vessel and her machinery. A 12-ton capacity evaporator is installed for making up fresh water losses, also a vertical multi-coil feed-water heater, both of Griscom-Spencer Company make.

The vessel has two main single-ended Scotch boilers, 12 feet diameter by 11 feet 6 inches long, each boiler having three furnaces. The steam pressure is 180 pounds per square inch. A vertical donkey boiler, 4 feet 6 inches diameter by 9 feet high, is located on the main deck. Settling tanks are built in the boiler room in connection with the fuel oil system; one oil tank pump and two oil fuel pumps are installed. The system of supplying oil to the furnaces for combustion and the arrangement of burners is such that no steam or compressed air is required for atomizing the oil, and is known as the Dahl's patent oil-burning system, as manufactured by the Union Iron Works, of San Francisco.

The vessel is lighted throughout by electricity, two generators, one of 13 kilowatts and one of 6.6 kilowatts capacity, being installed, and each direct connected to a De Laval steam turbine engine.

This vessel can carry 1,930 long tons cargo, 4,038 barrels of fuel oil and 100 tons of fresh water on a draft of 18 feet. She has accommodations for seventy first class and nine steerage passengers and carries a crew of thirty.

Five metal lifeboats and one working boat are placed on the boat deck with an efficient device for lowering same. The vessel is fully equipped for service to pass the United States inspection for fire-fighting, navigating and life-saving apparatus. Her gross tonnage is 2,273.50, net 1,406, the official number 209,655, signal letters L. C. H. P. On trial with ballast tanks full the vessel made a mean speed of 12 knots and developed 1,200 indicated horsepower. She is expected to make about 10 knots when loaded in service.

Sea-Going Tugs Sonoma and Ontario

Two single-screw, seagoing tugs, *Sonoma* and *Ontario,* are at present being completed by the New York Shipbuilding Company, at Camden, N. J., for the United States navy. Each vessel is of the following dimensions:

Length over all	185 feet 2 inches.
Length between perpendiculars (fore side of stem to after side of rudder post)	175 feet.
Beam, molded	34 feet.
Beam over guards	35 feet 6 inches.
Depth, molded, to main deck	20 feet 3 inches.
Mean load draft (salt water)	12 feet 6 inches.
Speed, loaded, at sea	14 knots.

The vessels are of open-hearth steel throughout, and built in accordance with the rules of the American Bureau of Shipping and under special survey. Each vessel is subdivided by seven watertight bulkheads, and has a raked stem and elliptical stern, two masts, with a derrick boom of 5 tons capacity on the foremast, schooner rig and a wireless outfit. These tugs are very large and powerful, being well adapted for the work they would be called upon to do in the event of war.

Quarters for a naval complement of four officers, three chief petty officers and thirty-five men are provided for.

There is fitted forward a steam windlass, combined with a towing bitt, the windlass having warping ends. A reversible capstan is fitted on the main deck aft. Two steam winches of 5 tons capacity each are located, one at the foremast on the main deck, the other at the main mast on top of the deck house. A towing machine is provided in the after end of the main deck house and supplied with necessary hawser rollers, etc.; a towing bitt is also fitted aft.

The steam steering engine is located in the engine room, and is connected with the pilot house; a combined steam and hand-steering wheel is fitted on the after end of the deck-house top. The vessel's boats consist of one 21-foot motor dory, one 28-foot whale boat and one 16-foot dinghy, the former two being slung under davits. One 4-inch Monitor fire hose nozzle is fitted on top of the pilot house and a similar one on top of the deck house aft. A machine shop, amply equipped, is located upon a platform on the port side of the engine room.

A double bottom and feed-water tanks are fitted under the boilers. Peak tanks are arranged for the carrying of fresh or salt water. The coal bunkers are abreast of the boiler room, and a cross-bunker is aft of the boiler room. The drinking water tanks contain 4,000 gallons of fresh water, and there is a gravity tank of 500 gallons. Refrigerator space is provided with a capacity of 550 cubic feet.

The propelling machinery is placed amidships, and consists of two single-ended Scotch boilers, arranged fore and aft, with the fire-room between the two. They are 16 feet in diameter and 11 feet between heads, with a working pressure of 200 pounds per square inch. The main engine is of the vertical, inverted cylinder, triple-expansion, surface-condensing type, of about 1,800 horsepower, with cylinders 19¾, 31½ and 54¼ inches diameter, respectively, with a common stroke of 36 inches.

New Steamship for Australian Service

The *Dimboola,* which was launched from the Neptune works of Swan, Hunter & Wigham Richardson, Ltd., on May 3, is being built to the order of the Melbourne Steamship Company, Ltd., of Melbourne, Australia, being intended for their passenger and cargo service on the southeast, south and west coasts of Australia. She will run between Sydney, New South Wales, and Geraldton, West Australia, calling at various intermediate ports, and she is expected to take about four weeks for the round trip.

The *Dimboola* is a finely proportioned steel steamer, 360 feet in length by 50 feet beam by 34 feet deep, with forecastle and poop and bridge combined. She is fitted with a double bottom all fore and aft. The propelling machinery will consist of a set of quadruple-expansion engines, which, with the boilers, are being constructed at the Neptune works. There is a fine promenade deck amidships, with a house containing the first class music room and staterooms for twelve first class passengers. Below this, on the bridge deck amidships, is the first class dining saloon, a handsome room, which will have seating accommodation for about sixty passengers. On the same deck near at hand are staterooms for sixty first class passengers. Close to these is a very comfortable smoking room for first class passengers. On the same deck, aft, the second class passengers have their dining saloon and a smoke room, while below are staterooms for seventy-four second class passengers.

As the carriage of cattle is an important feature in the trade for which this vessel is designed, space is arranged on the upper deck to carry about 150 head of cattle, while there are rooms for stockmen in attendance. The cargo arrangements are very complete, and the gear includes four steam cranes, three steam winches, a derrick for lifting specially heavy loads, etc. As the vessel will frequently be trading in very hot climates, special attention is paid to the ventilation of all spaces, and there is a refrigerating engine and insulated rooms.

Russian High-Speed Marine Diesel Engines

BY J. RENDELL WILSON

After the revelations, first made in the January issue of this journal, of the progress made with the installation of big Diesel engines in ships in Russia, it will not perhaps be a surprise to learn that the Maschinenfabriek Ludwig Nobel, of St. Petersburg, has perfected the high-speed, lightweight marine oil engine of this type, and we are again enabled to be the first to give some interesting illustrations and full details of a vertical Diesel engine of 180 brake-horsepower that weighs but 33 pounds per horsepower.

It is extremely unlikely that any other concern can claim the experience that Nobels have had in this direction, as during the last eight years the marine engines constructed by them aggregate 20,000 horsepower, while at the time of writing they have another 20,000-horsepower going through the shops, a large number of which have been ordered by Nobel Bros. Naphtha Company, the great oil firm. Altogether the number of Diesel engines, including land types actually supplied in thirteen years, is 500, aggregating 60,000 horsepower. With the marine sets their experience covers many types of vessels, including yachts, submarines, tugboats, passenger, mail, cargo and tankships, also six 1,000 brake-horsepower gunboats, while by the time these words are in print the engines for a Russian revenue cruiser will have been accepted, the trials of which were run during May at Nicolieff. The largest single engine yet installed is of only 1,000 horsepower, but, unfortunately, no details of this vessel and machinery are obtainable. It was six years ago that they completed their first reversible Diesel engine. Vessels engined by them previous to this date were used in conjunction with electric or pneumatic clutches and special reversing gears.

The perfection of the lightweight heavy oil engine is by no means a small achievement, and there is no limit for the development, especially for naval work, and it may eventually be the means of securing an unheard-of speed for torpedo boats, despatch boats and destroyers with perfect safety, as the fuel used is residue oil. Although for a Diesel engine, the running speed (450 revolutions per minute) is certainly on the high side, it is by no means impractical, and to obtain the same power for the cylinder bore and stroke a gasoline (petrol) engine would have to turn much faster, resulting in excessive piston speed. Again, the engine which I propose to describe first is only 9 feet long over all by 4 feet 9 inches high, or about the size and weight of an ordinary 50-horsepower marine kerosene (paraffin) engine and reverse gear, although nearly four times that horsepower is obtained, while the fuel consumption is nearly one-half. A very noteworthy and important fact.

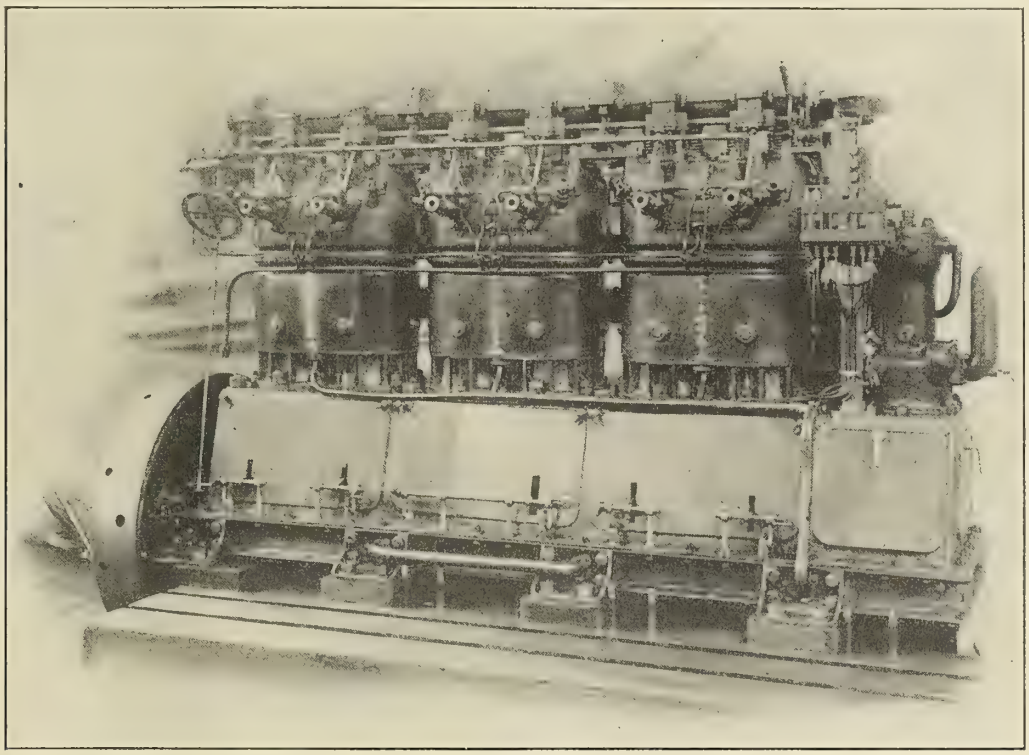


FIG. 1.—LUDWIG NOBEL 180-BRAKE-HORSEPOWER HIGH-SPEED MARINE DIESEL ENGINE

Figs. 1, 2 and 3 are illustrations of a six-cylinder non-reversible Nobel-Diesel marine engine of the four-cycle, single-acting vertical type, developing 180 horsepower at 450 revolutions per minute. Light weight is obtained by adopting an aluminum crankcase, and fitting sheet copper water-jackets to the cylinders, and by carefully designing every feature to obtain a minimum of size without sacrificing strength where such is required. Consequently the weight, with flywheel, is but 2 tons 13 cwts., that is to say, 33 pounds per horsepower, which is certainly a record in the history of the vertical Diesel engine. When one considers that the engine is of the four-cycle type, and that only one power impulse per cylinder is obtained every two revolutions the result is remarkable. There are six working cylinders, cast in pairs, each having a bore of 9 inches and 12 inches stroke, so that each cylinder gives over 68 horsepower for every *combustion stroke*, and, of course, half that figure every revolution. Fig. 3 is a drawing of this engine, while Fig. 2 depicts the valve arrangements on the cylinder heads.

At the forward end is a two-stage air compressor for providing the air for starting, reversing and fuel injection. This compressor forms an extension of the engine, and is driven off the crankshaft by a connecting rod. Mounted on the cylinder heads and running lengthwise is a camshaft (enclosed in an aluminum casing), which is operated by bevel gearing from a vertical spindle arranged between the forward cylinder and compressor, the drive from the crankshaft also being by bevel gearing. All the valves, with the exception of the fuel injection and air-starting valves, are actuated directly by the cams, the usual rocker arms being dispensed with, thus saving considerable weight. The fuel injection valve, it will be noted, is mounted on the starboard side of the

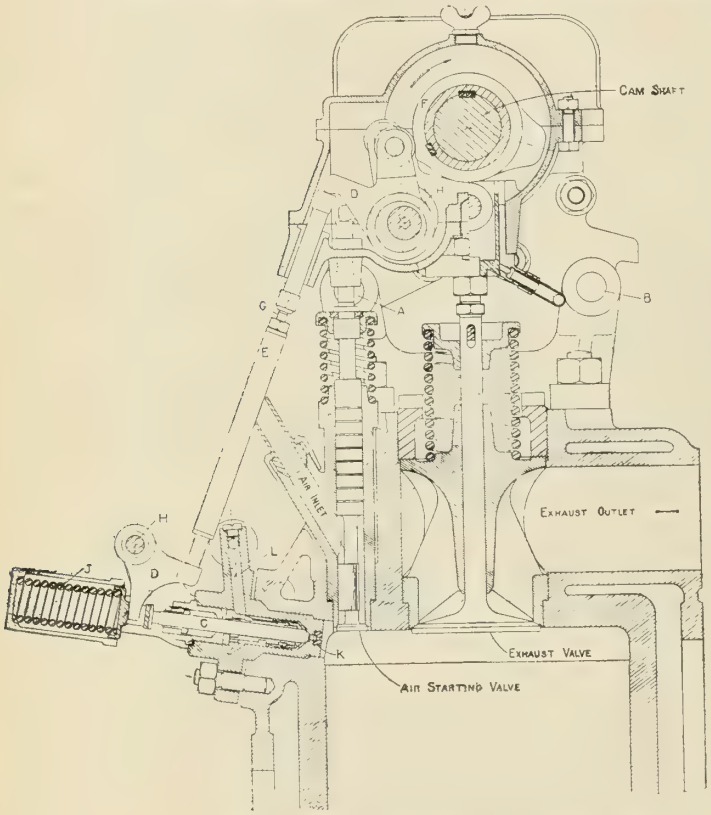


FIG. 2.—VALVE ARRANGEMENT IN CYLINDER HEAD

cylinder head, and is operated from its cam by two small rockers with a short intermediate shaft. Accessibility to the valves is a special feature, and any one can easily be taken out by removing the pins *A* (see Fig. 2), and by bodily swinging over the camshaft with its casing, the pins *B* forming hinges.

Turning for a moment to the fuel injection valve *C*, it will be seen that the cam *F*, which is turning at half-engine speed, operates the rocker D_1, which is eccentrically mounted at *H*, and the movement is transmitted by the rod *E* to the rocker *D*, which is mounted on a fulcrum at H_1. This rocker opens the fuel valve *C*, which shuts by the powerful spring *J*, air first blowing in the fuel at *K*, it being admitted at *L*. The rod *E* is adjustable at *G*; thus the lift of the fuel valve can easily be regulated.

The working action of the engine is as follows: For starting, air is admitted under pressure from a steel storage bottle to the cylinder, the piston of which has just passed the dead-center, and is commencing the down-stroke. This gives sufficient turning impetus for the other cylinders to come into play in turn; starting air is then, of course, shut off, the rocker operating the valve being mounted on an eccentric fulcrum, so is easily lifted clear of the cam by a hand lever. On the down-stroke of the piston that first picks up the load, air is drawn through a mushroom valve, via a silencing box, and on the up-stroke is compressed to 525 pounds per square inch. Just as the piston reaches the top of the compression stroke the fuel valve opens, and the oil (specific gravity 0.8 to 0.9) is injected by air blast from the high-stage compressor at 1,050 pounds per square inch. Combustion is instantaneous, and the next up-stroke is the exhaust. This cycle of operations is continually repeated with all cylinders as they pick up the load. Taking the cylinder compression into consideration the pressure used for fuel injection is unusally high. But this ensures the fuel being well sprayed across the combustion chamber for the purpose of perfect combustion. Thus the efficiency is very high, and the fuel consumption, I understand, ranges from 0.41 to 0.45 pound per brake-horsepower per hour, being exceptionally low figures. Control of the air and fuel valves is by a hand-wheel.

There are no cross-heads and guides, as the trunk type of piston has been adopted and the pistons are of ample length to take up the side thrust. Very large doors are provided to the crank case through which the pistons and connecting rods can be withdrawn and the main bearings examined. The fuel pumps, of which there are three, one for each pair of cylinders, are of the plunger type. They are mounted on the head of the after cylinder, and are driven by eccentrics on a lay shaft, which is operated by pinions from the overhead camshaft. They are controlled by a centrifugal governor arranged in the flywheel. From each fuel pump the fuel pipe is led to a small distributing valve on each pair of cylinders which can be regulated by hand. Both lubricating and water-cooling arrangements are very complete, even the crank-case sump from which the oil is pumped being water-cooled. Before passing to the working parts the lubricating oil first passes to eight adjustable sight-fed lubricators arranged at the forward end of the engine. Another minor detail is that the camshaft is equipped with ball-bearing thrusts. This engine, of course, is more suitable for yachts rather than for commercial vessels. In fact, Mr. Ludwig Nobel has had two high-speed, 350-horsepower engines of the two-cycle type, but with open crank pits, installed in his new 120-foot yacht, with the result that a speed of 20 knots has been obtained.

I am also enabled to include some interesting illustrations of an 8-cylinder V-type Diesel engine (Figs. 5 and 6), developing 150 horsepower at 500 revolutions per minute, which has been driving Mr. Nobel's yacht *Intermezzo* for several years. The owner tells me that this engine has run at a much higher speed than its normal rate. He uses the yacht on the Neva, and she is 56½ feet long by 8 feet 3 inches beam, with 3 feet 10 inches draft on a displacement of 10 tons, and has a speed of 15 knots. Unlike the engine just described this particular model is reversible, reversing being carried out by longitudinally moving the cam-shaft by means of a hand lever at the forward end, which brings another set of cams into action. At the same time the small hand-wheel, arranged at the side of the lever, is turned, which shuts off the fuel and admits compressed air to the pistons on the up-stroke, turning the crankshaft in the reverse direction. Another slight turn of the hand-wheel shuts the air valve and opens the fuel valve, allowing all cylinders to pick up the load. It will be noted that the cam-shaft is arranged in the apex of the V formed by the junction of the cylinders, from which the valves in the cylinder heads are operated by means of push rods and rockers. As there are four valves to each cylinder, the cam-shaft, which is driven by gearing from the crankshaft at the after end, has to operate no fewer than thirty-two valves. The cylinders have sheet copper water-jackets, and the crank-case and valve casing are both of aluminum. Admission to the crank-case is by a large door at the forward end and by a series of small removable plates just under the

cam-shaft, which is raised clear of the crank-case, being supported by five strong aluminum brackets.

To all appearances there are ten cylinders, but the fifth cylinder on each side at the forward end is an air compressor, the low stage being on the starboard (left side of illustration) and the high stage to the port side. The low-pressure air is utilized for starting and reversing, while the high-pressure air is for fuel injection. Each cylinder has a bore of 8 inches by 8½ inches stroke, and every pair is arranged facing, the connecting rod of the one cylinder being forked to receive the other; thus every throw of the crank-shaft, with its big end, is sufficient for two cylinders. The pistons are of the trunk type. A water-cooled silencer is arranged along each side

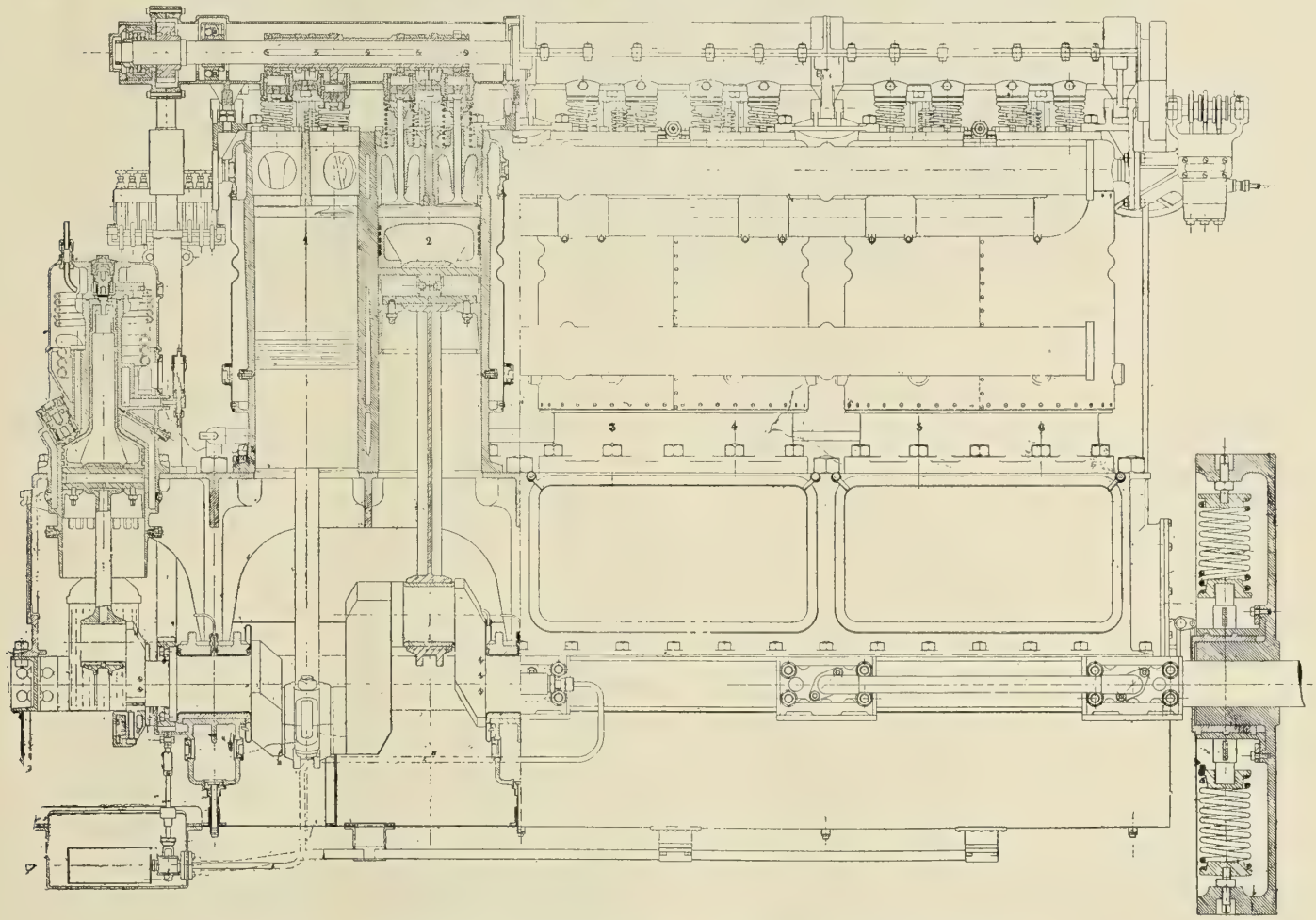


FIG. 3.—SECTIONAL DRAWING OF SIX-CYLINDER 180-HORSEPOWER NOBEL-DIESEL ENGINE

of the crank-case. At the forward end, by the control levers, is mounted a sight-feed lubricator, there being fifteen force-fed oil drips, which are carried to the chief working parts. The weight of this engine is even more noteworthy than the vertical model just described, but from the general design this may be expected. Its total weight, with flywheel and compressors, is but 2 tons; that is to say, 30 pounds per brake-horsepower; certainly an extraordinarily low figure, considering that the engine is directly reversible. The figure is such that the engine should give excellent results in a racing boat, despite the fact a fairly large propeller would be required; also, it must be remembered that this engine can maintain a much higher turning speed if necessary, while I understand that it will run smoothly at 200 revolutions per minute—not an inconsiderable radius.

Let us now turn to Fig. 4. This engine is also of the high-speed Diesel type, but of slightly heavier build than the engines just described. Working on the four-stroke principle it has four cylinders, cast in pairs, and develops 125 brake-horsepower at 450 revolutions per minute. In this case the metal used for the cylinders and crank-case is cast iron, and an engine of this type seems suitable for tugs, fishing vessels, vedette boats or small cargo craft. The flywheel, too, is much larger and heavier than with the lightweight motors. Its over-all length, including flywheel, is 7 feet 6 inches, and its height is 4 feet 8 inches from the center of the crankshaft. All the valves are arranged on the cylinder heads, although the fuel-injection valves are on the starboard side of the cylinder heads. They are operated by rockers and long push-rods from a cam-shaft, which is arranged on the crank-case at the starboard side. The cam-shaft itself is driven by enclosed gearing from the crank-shaft at the after end, while the two-stage compressor is driven direct off the crank-shaft at the forward end. It is interesting to note that the cam-shaft serves four purposes in addition to operating the four valves to each cylinder. Between the two pairs of cylinders are four fuel pumps of the plunger type, one to each cylinder, and these are operated by eccentrics on the cam-shaft. At the after end the cam-shaft actuates a centrifugal governor which is connected to the fuel pumps by a steel rod, and when the engine-speed is excessive shuts off the fuel supply. At the forward end of the cam-shaft is operated a set of five plunger lubricating pumps, also a large rotary water-circulating pump. The two levers on the cylinder heads are apparently for raising the rollers of the rockers operating the fuel and inlet valves clear of the tappets when reversing. In this case these rockers must be mounted on eccentric fulcrums. The lever for bodily

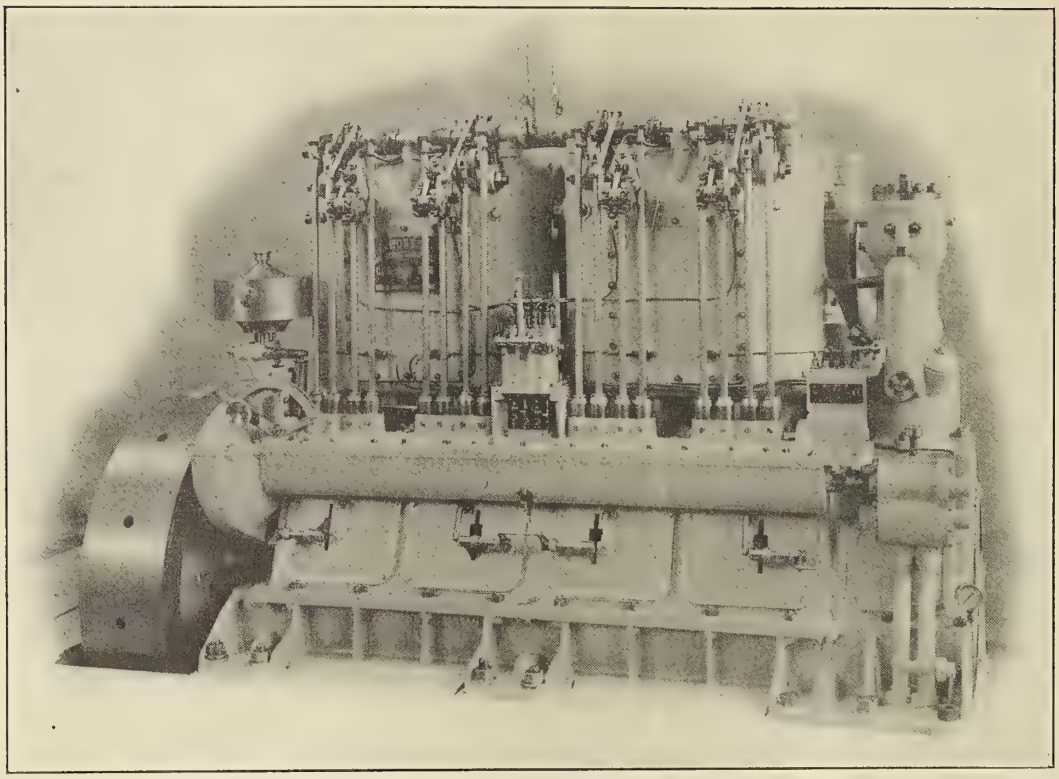


FIG. 4.—125-BRAKE-HORSEPOWER FOUR-CYLINDER DIESEL ENGINE. 450 REVOLUTIONS PER MINUTE

shifting the cam-shaft for reversing can be seen at the after end; the action of moving the cam-shaft brings, of course, another set of cams into action. With this engine the trunk-type of piston has also been adopted.

EDITORIAL NOTE:—Owing to the difficulties of translating from the Russian language it is possible that one or two slight errors—not necessarily the author's—may have crept in, but Mr. Wilson has paid the greatest attention to the accuracy of the figures quoted. On account of the vast resources of petroleum in Russia it is not strange that the engineers of that country should be among the pioneers in the development of this type of engine.

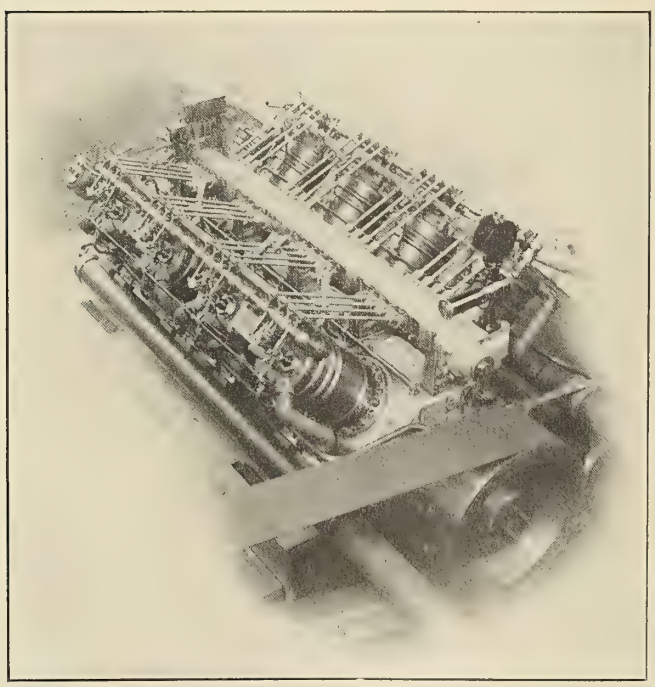


FIG. 5—EIGHT-CYLINDER, V-TYPE NOBEL-DIESEL ENGINE

The Robert Muser

A side-wheel, shallow-draft towboat, which is said to be the most powerful tug on the River Rhine, was built some time ago by Messrs. Gebr. Sachensberg, Rosslau (Elbe), for the Harpen Collieries, Mudheim, Ruhr. The vessel is 246 feet long, 68.8 feet beam, with a depth of 4.3 feet. The machinery consists of one triple-expansion engine, capable of developing about 2,000 horsepower. This vessel was christened the *Robert Müser*. Under ordinary circumstances the

THE MOST POWERFUL SIDE-WHEEL TUG ON THE RHINE

boat carries a tow of from four to six barges, with a total capacity of about 6,500 tons, up the river against the current. The boat was built especially for the coal-carrying trade on the middle and upper reaches of the Rhine between Duisberg and Mannheim. After the steamer was completed she made the voyage from the Elbe to the Rhine under her own steam, and, in spite of encountering very rough water, she showed admirable qualities, and arrived at Rotterdam without damage.

The Bureau of Navigation reports 269 sailing, steam and unrigged vessels of 35,302 gross tons built in the United States and officially numbered during the month of May, 1912. Of the steel steamers, six, aggregating 7,308 gross tons, were built on the Atlantic and Gulf coasts, and four, aggregating 9,047 gross tons, were built on the Great Lakes.

The Diesel Engine—Its Application to Ship Propulsion*

BY DR. RUDOLF DIESEL

There have been so many articles published recently, and especially during the past year, in technical periodicals of all languages, on the construction of the Diesel engine and its various types, that it is hardly possible to give any fresh information on the subject. The author, therefore, proposes to admit as generally known the working principle and the construction of his engine and to discuss only questions of general importance.

EFFICIENCY

Since its first appearance in 1897 the Diesel engine has been built by the thousands in the best factories of all industrial countries, and has been set up in the most remote corners of the world. It has proved to be a most reliable engine when properly built, and to-day the thermal or indicated efficiency reaches 48 percent in this engine, and the effective or brake efficiency reaches, in some cases, 35 percent of the heat value of the fuel.

The Diesel engine is the only engine which converts the heat of the natural fuel into work in the cylinder itself without any previous transforming process, and which utilizes it as completely as the present advancement of science permits; it is, therefore, the simplest, and at the same time the most economical, prime mover. These two facts explain the success of the Diesel principle, which lies in the new method of the internal working process and not in constructional improvements of older types of engine.

A further reason for this success is that the Diesel engine has broken the monopoly of coal and has solved the problem of using liquid fuel for power production in its simplest and most general form. It has become for all liquid fuels what the steam engine and gas engine are for coal, but in a much simpler and more economical way. The truth of this statement was strikingly proven at the Turin Exhibition of last year. At this Exhibition, in the large Machinery Hall, a steam turbine and a large Diesel engine, both made by Franco Tosi, of Milan, and set up on the same stand, were worked together with the same liquid fuel. The boilers of the steam plant were fitted with Koerting nozzles for burning crude oil.

The difference between the two plants was, therefore, this: For the working of the steam engine the complete boiler plant, with its chimney, fuel supply apparatus, purification plant for feed water, with feed pumps, extensive steam pipes, condensation plant with water pumps and an enormous quantity of water, had to be provided, with the final result of consuming two and one-half or more times the fuel per horsepower required by the Diesel engine standing beside it. The latter, being an entirely self-contained engine without any auxiliary plant, took up its crude fuel automatically and consumed it direct in its cylinders without any residue or smoke.

FUEL

Thus the Diesel engine has doubled the resources of mankind as regards power production, and has made new and hitherto unutilized products of Nature available for motor power. The Diesel engine has thereby exercised a far-reaching influence on the liquid fuel industry, which is at the present time improving more rapidly than was previously conceivable. It has been proved by recent geological researches, not only that there is probably on the globe as much, or perhaps even more, liquid fuel than coal, but also that it is more conveniently distributed as regards its geographical position. That the auxiliary industries of petroleum production are also considerably influenced, is shown by the great increase which the transport industry for liquid fuel has experienced in recent times, especially the great development of tank vessels, which are, or will be, mostly driven by Diesel engines.

But with all this, the influence of the Diesel engine in the world's industries is not exhausted. As early as the year 1899 the author utilized in his experimental engine the by-products of coal distillation and coke plants, such as tar and creosote oils, with the same satisfactory results as with natural liquid fuels; but at that time the quality of these oils was generally too inferior for their use in the Diesel engine, and it was, moreover, subject to continual variation. It is only in recent years that the chemical industries interested in the matter have, by improved methods of fractioning and refining, combined with more careful selection of the material, succeeded in supplying fuel of a constant and regular quality without the drawbacks of the crude tar oil used previously. These products—the tar and tar oil—are thus, to-day, definitely brought into the sphere of activity of the Diesel engine. This fact is, perhaps, not of so great an importance to the United States on account of its richness in natural oil, but it is of the utmost importance for European countries, and especially for those countries which do not have an oil production of their own; and it may be of some interest to state that, for instance, the tar production of Germany is sufficient for more than five billions of horsepower-hours per year, which means about one and three-quarter millions of horsepower running three hundred days, ten hours each, all the year. In case of war and the consequent cutting off of the supply of foreign fuel, this quantity would be sufficient for running the whole fleet, war and mercantile, and for providing in the meantime the power for the inland industries as far as necessary.

One fact stands out clearly in this connection—namely, that coal, which seemed to be most threatened by the liquid fuels, will, on the contrary, gain a new and wider ground of application through the Diesel engine. As tar and tar oils are from three to five times better utilized in the Diesel engine than coal in the steam engine, a much better and more economical utilization of coal is obtained if, instead of being burned under boilers on grates in a wasteful way, it is first transformed into coke and tar by distillation. Coke is used for metallurgical and other general heating purposes; from the tar the valuable by-products are first extracted and undergo further processes in the chemical industry, while the tar oils, the combustible by-products and a large part of the tar itself are burned in the Diesel engine under extraordinarily favorable conditions.

It is evident that these circumstances are of different importance and value in different countries. Some are exclusive coal-producing countries, others exclusive oil-producing countries, and still others produce coal and oil, like the United States. It is difficult to predict what development will take place in a given country, but it is certain that the possibility of burning the by-products of gas works and coke ovens in the Diesel engine has had in Europe the effect of making the different countries independent for their supply of liquid fuels, in preventing the increase of prices for the natural liquid fuels and the establishment of trust or monopoly companies. This condition has been reached in Europe.

From what has been said the following statement may be made: The proper development of the utilization of fuel

*Abstract of a paper on "The Present Status of the Diesel Engine in Europe and a Few Reminiscences of the Pioneer Work in America," read before the American Society of Mechanical Engineers, New York, April, 1912.

which has already been started and is now making rapid progress, comprises, on the one hand, liquid fuel in Diesel engines, and, on the other hand, gas fuel, in the form of gasified coke, in the gas engines; solid fuel, as little as possible, for power generation, but as much as possible in the refined form of coke for all other heating and metallurgical purposes.

It is not generally known that it is also possible to burn vegetable oils and animal oils in the Diesel engine without any difficulty. The author made the first trials with earth-nut oil (botanical name, Arachis hypogæa—an oil which is extensively obtained from a plant growing abundantly in the tropical wildernesses of Africa) at the Paris Exhibition in 1900, and has since then repeated them with castor oil and palm oil and also with animal oils. The use of vegetable oils may seem insignificant to-day, but such oils may become in course of time as equally important as some natural mineral oils and the tar products are at the present time. One cannot tell what part these oils will play in the colonies of the future. In any case, they make it certain that motor power can still be produced from the heat of the sun, which is always available for agricultural purposes, even when all our natural stores of solid and liquid fuels are exhausted.

Marine Engines

The first Diesel marine engine was constructed in 1902 to 1903 in France, for use on a canal boat, by the French engineers Adrian Bochet and Frédéric Dyckhoff, in conjunction with the author. This engine had two pistons working in opposite directions and one cylinder, and worked on a four-stroke cycle. The great feature of this arrangement was the very high speed which was made possible by the perfect balance. This small engine was, as stated, used to drive a canal boat, and worked quite satisfactorily. Others were also built in various sizes up to several hundreds of horsepower for some French submarines by Sautter, Harlé & Co., Paris.

This type of engine is of no further practical interest to-day, but it has at least the historical interest of being the first Diesel engine to be used on a boat. Since the time mentioned, the evolution of the Diesel marine engine has steadily continued, stimulated chiefly by the demand for French submarines and Russian river boats. The author has already mentioned that later on the high-speed, four-stroke cycle engine, built for electric power stations, were made even lighter than before and used for French submarines and for Russian river vessels. These engines were not originally reversible; on the contrary, they were used to generate electricity by means of which the propellers were driven indirectly for maneuvering. The first reversing marine two-stroke cycle Diesel engine was built in 1895 by Messrs. Sulzer Bros. at Winterthur. At that time engineers were not quite clear as to the importance and value of the two-stroke cycle principle, and many firms went on trying for years to make the four-stroke cycle reversible. The first engine of this kind was built by Messrs. Nobel Bros. at St. Petersburg in the year 1908 and was fitted to a Russian submarine.

In many factories reversible four-stroke cycle marine engines are still built; but, on the whole, engineers are, for navigation purposes, inclined to abandon the four-stroke cycle engine entirely and to replace it by the two-stroke cycle engine.

For larger sizes of ship engines, no standard type can be designated as yet. Each ship and each engine must be treated individually. Although several of the engines of Diesel liners are yet four-stroke engines, it appears unquestioned that the large ship engines will develop on a two-stroke type with cross-heads and with exactly the number of revolutions wanted by the propeller, and that there is a tendency to make these engines as nearly as possible to resemble steam engines, even in those points where it would not be necessary, because the marine people adopt new things very much easier when they look similar to that to which they are accustomed.

It is generally known that very important experimental work is being done in different places for the purpose of developing high-power marine engines with cylinder units reaching 1,000 to 2,000 horsepower or more. Some manufacturers solved this problem with double-acting, others with single-acting cylinders, but all on the two-stroke cycle. The M. A. N. is experimenting on a 6,000 horsepower, two-stroke, double-acting engine, with three cylinders of 2,000 horsepower each. Messrs. Sulzer Bros. are just erecting a single cylinder of 2,000 horsepower single-acting, based on a construction which permits an entirely free expansion of the cylinder under the action of the varying temperatures. Krupp's Germania Yards have a 2,000 horsepower cylinder double-acting on the testing stand. Vickers Sons & Maxim are experimenting on a large scale with the double-acting, two-stroke cycle type. A cylinder unit of 1,000 to 1,200 horsepower has been built by Messrs. Carels Frères for experimental purposes.

If, as seems probable, these tests give satisfactory results, the era of very large Diesel engines has come. For motives of prudence, the various navies which are now fitting some warships with Diesel engines started with one Diesel only out of the two or three engines on board; the Diesel works alone when the ship is cruising, but for high speed steam is used as an auxiliary. It is evident that large warships will not be fitted solely with Diesel engines until practical tests on the high seas have proved to be completely successful.

Vessels Propelled by Diesel Engines

The author has compiled from publications and private sources a complete list of Diesel engine propelled ships, built or in course of construction up to November, 1911, which shows a total aggregate of 365, and an analysis of which shows the following distribution:

Oil tank vessels	about 30
Tugs	about 40
Motor sailing vessels	about 10
Merchant vessels (freight, passenger and combined freight and passenger vessels)	about 50 to 60
Fishing boats	about 15
Submarines	about 140
Warships (small cruisers, gunboats, mine-laying boats, and the like)	about 40
Small marine craft	about 20
Miscellaneous vessels	about 20

In the following the author will give a brief historical review of Diesel engine ships and the results of trials and journeys as far as a record of them has been obtainable.

One of the very first small cargo boats on the Lake of Geneva was the *Venoge*, fitted with non-reversing engine driving the propeller electrically. The captain maneuvers the ship from his bridge entirely by electrical controllers. The motor runs below him without any engine man. Already this first boat shows the characteristic features of the Diesel ship—namely, the motor is as far back as possible, the funnel is absent, the deck quite clear, and the whole body free for cargo.

The passenger vessel *Uto*, on the Lake of Zurich, 200 tons displacement, 250 to 260 horsepower, has made regular passenger trips on Lake Zurich since the summer of 1909. It is a converted steamer. Weight of the previous steam plant, including coal and water, 14.46 tons for 64.6 sea-miles radius. Weight of the new plant, for double the power and 646 sea-miles radius, is 9.6 tons. Cost of fuel, one-fourth of the previous cost. Saving in labor, one man.

The German tug *Fortschritt,* in Hamburg harbor, is equipped with a 150 horsepower Diesel engine. It made very stormy voyages on the open sea and carried fuel for eight days. Gain in length one-third over a steamer. The gain in weight of machinery about one-fourth over steam plant. Weight of fuel only 20 to 25 percent of weight of coal for the same power in a steamer.

The Russian tug *Jakut,* of a towing capacity of 4,000 tons, is equipped with 320 horsepower. The engines have already worked satisfactorily for two years. The maneuvering power is better than with steam engines. The *Jakut* and a steam ice-breaker went to the assistance of a ship and towed her out of the ice. On this occasion the fuel consumption of the *Jakut* was 4.3 tons, as compared with 32 tons by the steamer.

A Diesel boat is used as a tug on the Volga. The boat has a side wheel, and it ought to be mentioned that the Diesel engine is equally well suited for this type of propulsion as the screw propeller system.

The sailing vessel *San Antonio,* which is sailing between the Baltic and the Mediterranean, was the first sailing boat to be equipped with a Diesel motor for auxiliary power. The boat has proved so satisfactory that since then the auxiliary motor sailer is now being developed on a very large scale.

The motor sailer *Quevilly* is of about 6,500 tons displacement, with 600 to 700 horsepower on two propellers. The propellers can be uncoupled when using sails only; their resistance when running light causes a loss of speed of one-half knot. This is the first ship with Diesel engines to cross the Atlantic. After the very good record of this ship, the same owners are now building another motor sailer.

The largest sailing vessel in the world is *La France,* a five-master of 10,730 tons displacement. Length, 430 feet. Sail area, 69,966 square feet. Auxiliary motor power, 1,800 to 2,000 horsepower in two Diesel engines. Will run between France and New Caledonia for the Caledonian ore trade. Was launched on the 16th of November, 1911.

The old North Polar ship *Fram* is fitted with Diesel engines. Gain through replacing the steam engines by Diesel engines: in engine space, 45 percent; weight of engine, 60 percent; weight of fuel, 80 percent; space for fuel, 85 percent. Several years' supply of fuel can be stored. Of 380 tons cargo capacity, 100 tons were previously required for the coal storage. The *Fram* sailed for six months from Christiania to the South Polar regions without touching land and without reporting. During the voyage in the Antarctic the engine worked for 2,800 hours without giving any trouble. On March 13, 1912, Capt. Amundsen, on his return from the South Pole, wired these few words: "Diesel engine excellent."

Diesel engines are installed in the Russian oil tank vessel *Dielo,* 5,700 tons displacement, 1,000 to 1,200 horsepower. This vessel made several stormy voyages on the Caspian Sea in the year 1911. It illustrates very clearly the special features of the Diesel ship; the entirely clear deck from one end to the other, no funnels, and only two small exhaust pipes on the stern, with invisible exhaust; engines on the rear end of the ship with the ship body free for cargo.

There are now a large number of oil tank vessels under course of construction in Europe; the largest one is being built by Krupp in Germany for the German Standard Oil Company; it will be 525 feet long, and will have a carrying capacity of 15,000 tons of oil.

The latest passenger and freight boat of Nobel Bros. on the Volga is the *Borodino,* equipped with two Diesel engines of 1,200 horsepower each. This boat was launched and made her trials towards the end of 1911. There are six of these boats in commission, and a ship of the same kind is being built at this time at Cockerills, in Belgium, for use on the Congo river, on order of the King of Belgium. This will be the first steel ship on colonial rivers.

To-day the navies of the world have adopted Diesel engines almost exclusively as the motive power for submarines. The submersible boat *Hvalon,* of the Swedish navy, was constructed by the F. I. A. T. Co., Italy. She is quite a modern boat, of 125 tons displacement. She left Spezia on July 30, 1911, and arrived at Cartagena, Spain, August 2, 1911, having covered the distance of 700 nautical miles without stopping. She then went to Portsmouth, thence to Kiel and Stockholm. A complete voyage of 4,000 miles was accomplished without escort and without mishap. She met with very rough weather, but behaved very satisfactorily and won high praise from her commander, Captain Magnussen. The ship is propelled by three sets of Diesel engines.

The Russian gunboat *Schtorm* is also fitted with Diesel engines. This boat, as well as two of her sister-ships, is stationed on the River Amur, in Asiatic Russia. The Russian gunboat *Kars* and her sister-ship *Ardagon,* stationed in the Caspian Sea, both have Diesel engines developing 1,000 horsepower on two propellers. The engines are of the two-cylinder, four-stroke type. Tests made in 1911 show a consumption of 333 pounds, with oil, against 1,250 to 1,390 pounds with coal.

A comparison has been made between two torpedo-boat destroyers with Diesel engines and with steam engines. In the Diesel ship the deck is perfectly free, permitting a much stronger gun equipment. The radius of action of the Diesel ship is six and a half times the radius of a steam ship. The space for the engines is one-half, which increases considerably the space for the accommodation of officers and the crew. It is of particular importance that in the Diesel ship the engines are entirely placed under the armored deck, while in the steam ship the steam engines and boilers reach up nearly to the upper deck, and the deck is surmounted by smokestacks. Such a Diesel engined destroyer is now being built in England. A similar comparison has also been made by English naval engineers for battleships. It is even more pronounced here than in the above comparison that the Diesel engines are entirely under the water line, which makes the ship invulnerable from the enemy, as far as her engines are concerned, and the fighting power of the ship is greatly increased.

Two sister-ships, the *Rapp* and *Snapp,* are small merchant vessels cruising in Swedish waters, of a cargo capacity of 300 tons and equipped with 120 horsepower. The engines run for long periods at 55 to 60 revolutions, although the normal speed is 300 revolutions. Since 1908 the vessels have made numerous voyages between Sweden, Finland, Germany, Holland, England, Iceland and Norway. On a voyage from the east to the west coast of Sweden, through the canal, 75 locks had to be passed, through which the maneuvering power seemed to be very satisfactory.

The first Diesel-engined seagoing vessel was the *Toiler,* cargo capacity about 3,000 tons; 360 horsepower. The steering is controlled by compressed air. The cabins are warmed by hot water, heated by the exhaust from the engines. First voyage from the Tyne to Calais with a cargo of coal was made in the summer of 1911 in very bad weather. Oil consumption, 1.65 to 1.75 tons in twenty-four hours. A steamer of the same size consumes 8 to 9 tons of coal per day; saving in cost of fuel, as compared with steamer, 50 percent. Gain in cargo capacity, 60 tons. Voyage to North America in September, 1911. Fuel consumption, 2 tons per day. Saving in cost of fuel, as compared with steam plant, $11 (2/5/10); saving in labor, $5 (1/0/10) per day. Maneuvering power proved to be very satisfactory.

The *Romagna,* of 1,000 tons displacement, 800 horsepower, was put in commission in 1910 and made regular voyages be-

tween Ravenna-Trieste-Fiume during the summer of 1911. In consequence of the faulty loading of the cargo, the vessel sank in a terrible sirocco in November, 1911.

A Diesel-engined Hamburg-American liner of 6,500 tons is under construction at the yards of the Aktien-Gesellschaft Weser, of Bremen. She will have two Diesel engines of 2,000 indicated horsepower each, and will be delivered to her owners about the middle of this year.

It is a peculiar coincidence that one hundred years separate two such events as the introduction of the marine steam engine on the River Clyde and the launching at Glasgow of the first Diesel liner built in the United Kingdom. The latter is the freight and passenger ship *Jutlandia,* which is now being completed by Messrs. Barclay, Curle & Co., and will run between Europe and Siam. The ship is of 5,000 gross tons, and will have engines of 3,000 horsepower. The fuel is carried in the vessel's double bottom. The accommodations for her passengers will be excellent; she will have magnificent staterooms, each with its own bathroom. There is a large dining saloon, smoking and music rooms. This luxurious accommodation is due to gain in space from the Diesel engine. This ship has no dangerous steam mains running everywhere, the dreaded and dirty operation of coaling is absent, and while the passengers enjoy the absence of heat from the boilers and smoke from the funnels, the owner will remember that the firemen's quarters, the boiler and bunker space, and the room occupied by numerous ventilation shafts and the funnel up-takes, may be utilized for carrying more passengers and freight, this gain in the *Jutlandia* being more than 20 percent. The exhaust from the engines will be carried up the hollow steel mizzenmast, so that no fumes reach the passengers. In place of twenty-five engineers and stokers in a similar steam-driven vessel, only eight engineers will be required to operate the new Diesel vessel.

This ship is practically a sister-ship of the *Selandia,* built by Burmeister & Wain, Copenhagen, which has been thoroughly described in previous issues of INTERNATIONAL MARINE ENGINEERING. The *Selandia* has now made her first trip to Bangkok, and it has been very successful. The cargo is 1,000 tons more than in a steamship of the same size. The owners anticipate a saving per annum in the fuel bill of $25,000 (£5,120), and a gain in the yearly freight receipts of about $15,000 (£3,080). The East Asiatic Co., owners of the *Selandia,* have just placed orders for eleven Diesel ocean liners of the same type and of tonnage ranging from 6,000 to 10,000 tons.

Floating Dock for the British Admiralty

An immense floating dock for the British Admiralty has been under construction this year at the Wallsend shipyard of Swan, Hunter & Wigham Richardson, Ltd. Some idea may be gained of its size when it is known that the ground area it covers is no less than two and a quarter acres, while the total height of the side walls is 66 feet. This is one of three docks that Swan, Hunter & Wigham Richardson, Ltd., are constructing at present for the British Admiralty, for whom they also built a battleship dock several years ago. This last named was designed for accommodating vessels displacing 17,000 tons, and is stationed at Bermuda. The latest dock has nearly twice that lifting capacity, namely, 32,000 tons. In addition to the docks built by Swan, Hunter & Wigham Richardson, Ltd., for the British Admiralty others have been constructed at the Wallsend shipyard for the governments of Natal, Southern Nigeria, Spain and Japan, and also a score for British and foreign clients all over the world. The way in which these immense structures can be towed to distant parts is most remarkable. The British Admiralty dock for Bermuda was towed nearly 4,000 miles to its destination. The floating dock for the Natal Government was towed over 8,000 miles to Durban, and a 7,000-ton dock was safely delivered a year or two ago at Callao, the port of Lima, in Peru, the distance from the Wallsend shipyard being about 11,000 miles. Other docks built by Swan, Hunter & Wigham Richardson, Ltd., have been towed to various European ports, and also to more distant one, such as Para (in Brazil), Port of Spain (in the island of Trinidad), Egypt, and the West Coast of Africa.

The dock that has just been launched is double sided, and in designing it the builders have been closely associated with Messrs. Clark & Standfield, of Westminster. At the bow end of the dock there is a pair of pivoted flying gangways, to give access from one wall of the dock to the other. In the walls of the dock is living accommodation for a number of officers and men. A complete telephone system is also installed to give communication between the engine and boiler rooms and different parts of the dock. There are eight steam boilers, which have been constructed at the Neptune Engine Works of the builders. The pumps have been supplied by Messrs. Gwynnes, Ltd. There is also a very complete outfit of steam and hand capstans placed on the walls of the dock to warp vessels into position. The dock is lighted by electricity throughout, and on the walls are two electric traveling cranes. In order to facilitate rapid repairs a commodious workshop is provided in one of the walls with an equipment of machine tools and all necessary plant and appliances. Preservative bituminous enamel in solution, made by W. Briggs & Sons, Ltd., of Dundee, has been applied to the dock externally and internally.

A River Plate Steamer

El Uruguayo is the name of a twin-screw steamer built by Messrs Alexander Stephen & Sons, Linthouse, Glasgow, for the new fortnightly service which Furness, Withy & Co., Ltd., are establishing between Liverpool and the River Plate. This service is to alternate with that of the Royal Mail Steam Packet Company.

The steamer is the first vessel to be constructed for the new service, and she is the largest vessel ever entirely designed for the carriage of chilled and frozen meat. Her insulated capacity is over 400,000 cubic feet.

This vessel is 456 feet in length over all by 59 feet beam by 38 feet molded depth. Of the shelter deck type, she has four complete decks fore and aft, with long bridge and boat deck amidships and a forecastle forward. The hull was constructed in details specially arranged by the builders with the British Corporation for the work of insulation and in accordance with the requirements of the meat-carrying trade. The shell, underside of decks, bulkheads and tank tops are insulated with granulated cork, and all the decks in the refrigerated spaces are laid with Litosilo.

For effective cargo working the hatches are trunked and insulated through the four decks, so that any part of the ship can be loaded or discharged without affecting the refrigeration of the remaining portions. The hatch trunks are arranged for the reception of carcasses.

All the cargo gear, derricks and winches have been arranged so that three gangs of men can work simultaneously at each of the large hatches. This will permit of the rapid discharge of an enormous cargo of meat.

The work of insulation is carried out by the builders and the refrigeratiing machinery is installed by Messrs. J. & E. Hall, Dartford. Each chamber is cooled by brine circulation to a temperature suitable for chilled or frozen meat. The machinery is controlled entirely from the refrigerating engine room, and the brine grids are specially designed for chilling as well as freezing meat. The refrigeration machinery is in duplicate throughout.

The propelling machinery constructed by the builders consists of twin-screw, triple-expansion engines with cylinders 25 inches, 41½ inches and 70 inches diameter by 48 inches stroke. Steam is supplied from six large boilers working under Howden's system of forced draft at a pressure of 200 pounds. There is a large outfit of auxiliary machinery.

On the bridge deck accommodation is provided for officers and engineers. There are also staterooms, saloon, smoke room, etc., for a limited number of first class passengers. And inside the bridge and poop are comfortable quarters for about 400 emigrants.

The work of construction, both of hull and machinery, has been under the supervision of Messrs. William Esplen & Son, Liverpool.

Launch of the Latest British Battleships and Battle Cruisers

The launch by Scotts' Shipbuilding & Engineering Company, Greenock, of the latest super-dreadnought battlehip for the British navy, together with the launch at Jarrow of the battle cruiser *Queen Mary,* makes a remarkable record in the story of any fleet. The addition, on consecutive days, of two vessels, each the largest and most powerful of its class, and each more powerful than any ships of the same type yet built for any other navy, marks a very definite stage in British naval progress. The battleship *Ajax* was laid down at Greenock on Feb. 27, 1911, and will be commissioned early next year. Scotts' Company build not only the hull but also the turbines and boilers and all the other necessary machinery.

From the time when the vessel began to move on the ways until she was fully water-borne seventy seconds elapsed. The launching weight of the hull was rather more than 9,000 tons, and the breadth of the launching ways was 6 feet. The vessel was released by the old method of dogshores and falling weights, the mechanism working perfectly.

The *Ajax* is a battleship of the *Dreadnought* type, with better armor protection than the original ship, 13.5-inch guns instead of 12-inch guns in her main armament, and 4-inch guns instead of 12-pounders in her anti-torpedo boat armament. The *Dreadnought's* greatest broadside fire is 6,800 pounds, from eight 12-inch 45-caliber guns; that of the *Ajax* will be 12,500 pounds, from ten 13.5-inch guns. The guns of the *Ajax* are installed in pairs in turrets on the middle line of the ship. The *Colossus* is also able to use all of her ten 12-inch 50-caliber guns on either beam, two of her five turrets being placed *en echelon* on the wings. Her greatest broadside fire is, roughly, 8,500 pounds, as compared with 6,800 pounds for the *Dreadnought* and 12,500 pounds for the *Ajax*. The *Dreadnought* has twenty-seven 12-pounders in her anti-torpedo boat armament. The corresponding provision in the *Ajax* is, as in the *Colossus,* sixteen 4-inch guns. They are single-tier armored batteries, and are disposed so as to give the best possible protection against torpedo attack.

The main armor protection is also better. The side armor, greatest thickness 12 inches, extends for nearly two-thirds of the vessel's length. The two lower strakes are of 12 inches, above that is one of 9 inches and above that one of 18 inches. Forward and aft of the heavily protected part of the ship armor tapering from a thickness of 6 inches extends to the stem and the stern.

All this increase of offensive and defensive qualities finds expression in larger dimensions. Between perpendiculars the *Ajax* is 555 feet long. Her beam is 89 feet 6 inches, and her draft 27 feet 6 inches. The displacement is slightly more than 23,000 tons. In order to drive the bigger ship at the same speed as that of the other *Dreadnought* the propelling machinery, which consists of Parsons turbines arranged for four screws, will develop about 31,000 shaft-horsepower. All the battleships of the *Dreadnought* type have designed speeds of 21 knots.

The launch of His Majesty's battle cruiser *Queen Mary* was from the yard of Palmer's Shipbuilding & Iron Company, Ltd., Jarrow.

The *Queen Mary* is the second largest vessel of any description ever launched on the Tyne, the largest being the *Mauretania,* launched at Wallsend. The *Queen Mary* is some 90 feet less than the *Mauretania* in length.

The *Queen Mary* is a dreadnought cruiser of the *Lion* class and of the *Invincible* type. Compared with the *Ajax* she has 105 feet more length between perpendiculars, about the same beam and 6 inches more draft. The displacement will be about 27,000 tons. The *Queen Mary* is practically a sister ship of the *Lion* and the *Princess Royal.* She is a similar ship to the *Tiger,* although there is a difference in beam between the *Princess Royal* and the *Tiger* of, roughly, 2 feet.

Comparing the *Queen Mary* with the *Invincible* she is between perpendiculars 130 feet longer than that vessel. Her beam is at least 10 feet greater, and she draws nearly 3 feet more water. Both ships can use all of the eight guns in their main armaments on either broadside, although the dispositions of the turrets are different. In the *Invincible* two turrets, each containing two guns, are placed *en echelon* on the wings. In the *Queen Mary* all the eight guns are in four turrets on the middle line. The *Invincible's* are 12-inch 45-caliber guns, while the *Queen Mary's* are 13.5-inch 50-caliber guns, so that in the case of the earlier ship the full broadside fire expressed in weight of projectile is 6,800 pounds, and in the case of the later ship 10,000 pounds.

The anti-torpedo guns in all the ships of the type up to the *Queen Mary* are of 4-inch caliber. Those in the later ships are better weapons and capable of much more effective use. In the *Queen Mary* the anti-torpedo armament is better disposed and better protected than it is in any ship prior to the *Lion.* The guns are in armor casemates, and not in unprotected batteries. The thickest side armor is on the *Queen Mary,* not much, if any, greater than that of the *Princess Royal,* which is 9 inches. The thickest side armor on the *Invincible* is 7 inches.

The designed speed of the *Queen Mary* is 28 knots, and to obtain this Parsons turbines are arranged for four screws, and estimated to give about 75,000 shaft-horsepower. They are provided by Messrs. John Brown & Company, Ltd., Clydebank. The designed speed of the *Invincible* was 25 knots, and the shaft-horsepower necessary to obtain it was estimated at 41,000. Actually the speed on trial was 28 knots with 44,800 shaft-horsepower.

Both the *Ajax* and the *Queen Mary* are much better ships than their predecessors. The primary duty of battleships was originally to control maritime communications, and of cruisers to exercise control under cover of the battleships. If a cruiser line exercising control was attacked by isolated heavier ships it had to concentrate or run, and in either case the control was broken. In order to repair this deficiency cruiser lines were given resisting power. That was the beginning of the development whose latest phase is the *Queen Mary.* Cruiser screens to battle fleets had to be correspondingly augmented. Then came the torpedo, until now armored cruisers are used not only to scout and to strengthen cruiser screens but in squadrons have been given definite tactical functions in battle. They screen, scout, control and fight in lines of battle. There is now no broad, dividing line between types of warships, judging the matter by the work they can do.

Analysis of the Trial Trips of the Battleship Florida

BY SIDNEY G. KOON, M. M. E.

Analyses of the results of the standardization and the official trials of this new dreadnought battleship give some interesting results. In the accompanying two diagrams are given fourteen curves derived from these analyses—the eight in Fig. 1 being based on the speed, and the six in Fig. 2 on the horsepower, as shown.

The "parent" curve, so to speak, is that for speed and shaft-horsepower, in Fig. 1. This is derived from a combination of

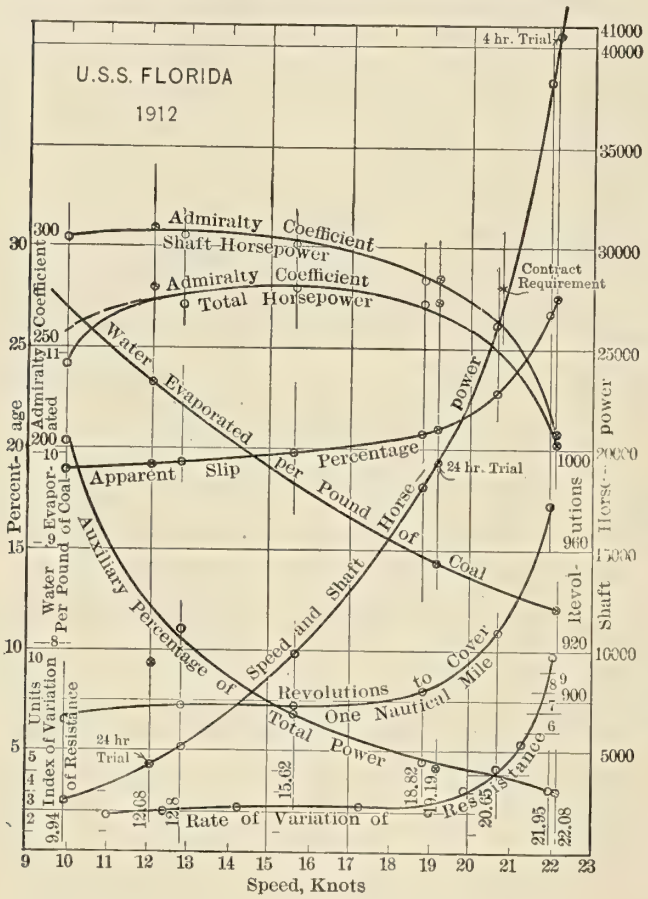


FIG. 1

the standardization trials and the three official trials. To illustrate how this curve was obtained from the separate runs on the standardization trials, with and against the tide, Table I. is given; while Table II. exhibits the final results of putting all the sections of the standardization trials through this same process. Each such section or group comprises naturally those runs made at approximately the same number of revolutions per minute.

From the results in Table I. and Table II. is readily obtained the information relating to the speed the "revolutions to cover 1 nautical mile." This is seen to be practically constant up to about 18 knots speed, indicating that the slip over this

TABLE I.

Run Number	7	8	9	A Mean 7 and 8.	B Mean 8 and 9.	Final Mean A and B.
Revolutions per minute	233.8	230.1	236.1	232.	233.1	232.5
Revolutions per mile	824.	959.	850.	891.5	904.5	898.
Speed, knots	17.03	14.39	16.67	15.71	15.53	15.62
Shaft horsepower	9742.	9872.	10108.	9807.	9990.	9899.
Auxiliary horsepower	755.	746.	723.	750.	735.	742.
Total horsepower	10497.	10618.	10831.	10557.	10725.	10641.

range is nearly constant—a fact brought out later. After reaching 18 knots the curve mounts abruptly. Reference to the apparent slip curve shows, naturally, a similar characteristic.

The curves for Admiralty coefficient are figured from the well-known formula

$$K = \frac{D^{2/3}\ V^3}{H},$$

where K is the coefficient sought, D is the displacement of the ship in tons, V is the speed in knots and H is the horsepower. Two curves are shown, in one of which H signifies the shaft-horsepower only, while in the other H is the total horsepower of the propelling machinery and all its auxiliaries. The former represents the theoretical hull efficiency, on the probably untenable assumption that the hull coefficient of propulsion is a constant. The latter represents the practical efficiency of sending the vessel through the water at varying rates of speed.

The curve showing percentage relation between horsepower of auxiliaries and total combined horsepower of propelling engines and their auxiliaries is taken direct from the figures given for the trials of the ship. It varies from more than 20 percent at 10 knots to a trifle over 3 percent at 22 knots. It will be shown later that the 20 percent auxiliary power at 10 knots absorbs more steam (and hence coal) than does the 80 percent propelling engine power at that speed. It will be noted that all the figures and curves given are taken from results of both standardization and official trials.

The apparent slip percentage curve was obtained by relating the speed at each point to the product of the propeller pitch (8½ feet) and the revolutions per minute. For instance, at 15.62 knots the speed of the ship is 1,583 feet per minute.

TABLE II.

Trial or run	4-5-6.	24-Hour.	1-2-3.	7-8-9.	10-11-12.	24-Hour.	20-21-22.	15 to 19.	4-Hour.
R. P. M.	146.3	178.5	189.2	232.5	283.2	289.5	319.	358.6	363.9
Revolutions, 1 mile	897.5	.....	899.	898.	904.	.....	927.1	980.5	.....
Speed	9.94	12.08	12.8	15.62	18.82	19.19	20.65	21.95	22.08
Shaft horsepower	2516.	4433.	5325.	9899.	18284.	19359.	25979.	38225.	40511.
Auxiliary horsepower	640.	464.	665.	742.	866.	863.	1119.	1240.	1299.
Total horsepower	3156.	4897.	5990.	10641.	19150.	20222.	27098.	39465.	41810.
V^3	982.	1763.	2097.	3811.	6666.	7067.	8806.	10576.	10765.
K_a	243.	281.2	273.4	279.7	271.8	272.9	253.8	209.3	201.1
K_b	304.8	310.6	307.6	300.7	284.8	285.1	264.7	216.1	207.5
Auxiliary horsepower, percent of total	20.27	9.48	11.1	6.97	4.52	4.27	4.13	3.14	3.11

a. Based on total horsepower.
b. Based on shaft horsepower only. $D^{2/3} = 781$.

The revolutions (232.5 per minute) multiplied by 8½ gives 1,976 feet per minute advance of the screw. The difference, or slip, is thus 393 feet per minute, which represents 19.9 percent of the propeller's own speed.

The ratio of variation of resistance is a very important consideration. The curve, which shows that the resistance varied about as the second power (the square) of the speed up to 19 knots, shows a sharp advance after that point is reached, until, at 22 knots, the index is nearly 10. The points on this curve were obtained on the assumption that the resistance index between any given speed reading and the next adjacent one was practically constant. This also assumes a constant propulsive coefficient.

Thus, if we refer to the formula $R = A\ V^x$, where A is a constant, V is the speed, R is the resistance at that speed, and x is the rate of variation of R, we are assuming x constant for relatively slight variations of V. Now $H = B\ V\ R$, where B is another constant. Then $H = B\ V\ A\ V^x = A\ B\ V^{(x+1)}$. Reduced to logarithms this last becomes $\log H = \log A\ B + (x + 1) \log V$; also $\log H_1 = \log A\ B + (x + 1) \log V_1$. Subtracting $\log H - \log H_1 = (x + 1)(\log V - \log V_1)$, whence $\log \frac{H}{H_1} = (x + 1) \log \frac{V}{V_1}$.

Taking the first step in our order of speeds, $V_1 = 9.94$; $V = 12.08$; $H_1 = 2516$; $H = 4433$. Then $\frac{H}{H_1} = 1.762$; $\frac{V}{V_1} = 1.215$; $\log \frac{H}{H_1} = 0.24601$; $\log \frac{V}{V_1} = 0.08458$. From this $x + 1 = 0.24601 \div 0.08458 = 2.909$, and $x = 1.909$. Thus the power varies as the 2.909 index of the speed, and the resistance as the 1.909 index of the speed as plotted on the curve. The other points on the curve were all obtained in the same way, and each was plotted on the mean between the two speeds compared. The result must be considered as approximate only, but the approximation may be assumed to be substantially correct.

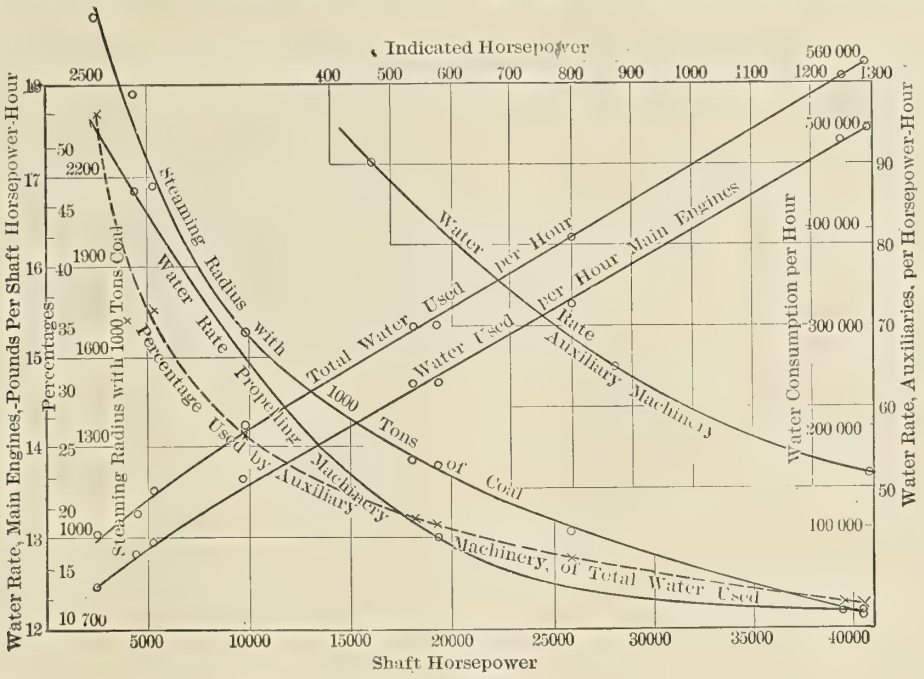

Indicated Horsepower
Water Rate, Main Engines, Pounds Per Shaft Horsepower-Hour
Water Rate, Auxiliaries, per Horsepower-Hour
Water Consumption per Hour
Percentages
Steaming Radius with 1000 Tons Coal
Water Rate Propelling Machinery
Percentage Used by Auxiliary Machinery
Total Water Used per Hour Main Engines
Water Used per Hour Auxiliary Machinery
1000 Tons of Coal
Machinery, of Total Water Used
Shaft Horsepower

FIG. 2

Turning next to Fig. 2 we have the water rate of the propelling machinery, the curve being drawn from three spots—those representing 12.08, 19.19 and 22.08 knots speed. Similarly, the curve for water rate of the auxiliary machinery is based on three spots, representing these same three speeds.

Using these curves as bases and the observed horsepowers, figures may be obtained for the water consumption per hour of both main and auxiliary machinery. These give the two curves running *"S. W. to N. E."* across the diagram. The lower curve gives results for the main engines only, the upper for main and auxiliary engines together.

TABLE III.

Shaft Horse-power.	Apparent Slip, Percent.	Index of Variation of Horse-power.	Index of Variation of Re-sistance.	Water Rate Propel-ling.	Water Rate Aux-iliaries.	Total Water Hourly Consump-tion, Pro-pelling.	Total Water Hourly Consump-tion, Aux-iliaries.	Total Water Hourly Con-sump-tion, All.	Total Water Hourly Con-sump-tion, Aux-iliary, Percent.	Water Con-sump-tion per Nautical Mile.	Water Evapo-rated per Pound of Coal.	Coal Burned per Nautical Mile.	Steaming Radius with 1,000 Tons of Coal, Miles.	Steaming Radius with 1,000 Tons of Coal, Hours.
2,516	18.99	.....	.....	17.58	.....	44,030	48,832	92,862	52.59	9,341	11.4	819	2,734	275.
4,433[a]	19.32	2.909	1.909	16.815	90.18	74,543	41,843	116,386	35.96	9,634	10.658	904	2,478	205.
5,325	19.35	3.172	2.172	16.43	76.3	87,490	49,875	137,365	36.31	10,732	10.425	1,029	2,176	170.
9,899	19.9	3.113	2.113	15.	75.	148,485	52,385	200,870	26.08	12,860	9.65	1,333	1,681	107.6
18,284	20.76	3.29	2.29	13.17	70.6	242,820	56,578	299,398	18.9	15,908	8.93	1,781	1,257	66.8
19,359[a]	20.98	3.	2.	13.	65.33	251,669	56,382	308,051	18.3	16,053	8.872	1,809	1,238	64.5
25,979	22.8	4.011	3.011	12.45	56.9	323,439	63,671	387,110	16.45	18,745	8.63	2,172	1,031	49.9
38,225	27.	6.322	5.322	12.2	53.5	466,345	66,340	532,685	12.41	24,959	8.45	2,954	758	34.5
40,511[b]	27.67	9.735	8.735	12.18	51.85	493,428	67,352	560,780	12.01	25,399	8.423	3,015	743	33.6

a. Twenty-four-hour official trials.
b. Four-hour trial. Others, standardization.

The percentage of water consumed by the auxiliary machinery to the total water consumed by all machinery, follows readily from the figures of the last paragraph. This, again, is represented by a curve.

Taking the curves as a whole, it will be noted that the most efficient propulsion is at about 16 knots. In this connection it is of interest to note that the total horsepower required by this 21,200-ton (trial displacement) ship at 15.62 knots was 10,641, or half horsepower per ton. The 10,225-ton *Indiana,* in 1896, for 15.55 knots required 9,607 indicated horsepower, or 0.94 horsepower per ton. Had the *Florida's* propulsion been only equally effective, this speed would have called for 16,145 horsepower, which would actually give her now a speed of over 18 knots. This power is more than 50 percent in excess of what the *Florida* actually required for the *Indiana's* speed.

This sort of result is splendid; so, from the point of view of the design of the ship and her powering, is the fact that the designed speed was obtained on almost exactly the 28,000 designed horsepower. But the obtaining of over 41,000 horsepower out of machinery designed for 28,000, while gratifying as showing the overload possibilities of her propelling apparatus, is not evidence of the best engineering design.

It is also evident that the ship was designed for 20.75 knots, and *no more;* for the extra 1 1/3 knots achieved cost an extra 14,000 horsepower, or an excess of 50 percent more power, in fact, than was absorbed by the first 17 knots. This is two and one-half times what it would have cost in a ship properly designed for the higher speed.

Those derived figures which are not found in the published records of the *Florida* are given in Table III.

Fast Steam Yacht Winchester Launched

The new turbine express steam yacht *Winchester* was successfully launched at the yard of the builder, Messrs. Yarrow & Co., Scotstoun, on May 15, and will be rapidly pushed to completion, so that she may be delivered to her owner, Mr. P. W. Rouss, at the earliest possible date. The yacht was designed by Messrs. Cox & Stevens, of New York, and the contract was awarded to Yarrow & Co. by reason of the very satisfactory results obtained in the previous *Winchester,* the construction of which Messrs. Cox & Stevens had also entrusted to the same builders.

The new *Winchester* is an entire departure from the conventional type of express steam yachts, and her appearance in these waters is looked forward to with much interest by all who follow progress in matters of this character. She is 205 feet in length, her beam is 18 feet 6 inches, and her contract speed, which the architects believe will be exceeded, is 32 knots. The propelling machinery consists of a twin-screw Parsons turbine installation, supplied with steam by water-tube boilers of the Yarrow type, oil-fired. In appearance, the hull is not unusual, and although the novelty of the design may to some appear so unusual as to lead to adverse criticism, anyone having actual knowledge of the results desired and a sense of the fitness of things nautical will at once appreciate its merits and the actual beauty of the lines.

The vessel has a flush deck throughout, having practically a straight sheer, and for a distance of about one-quarter the length from the stem the freeboard is raised to form an upper forecastle, as is done in the modern torpedo-boat destroyers. The deck dining-room, which is unusually large, is placed directly aft of this raised portion, and the forecastle deck is carried aft over the dining-room, forming one continuous level. By this means of construction the vessel has sufficient freeboard forward to enable her to be driven comfortably at high speeds, even in rough weather, and all possibility of the windows in the dining-room being broken by water coming on board is removed.

The awning runs in one continuous line from the break in the deck forward to the after end of the vessel, and there is a comfortable after-deck house to provide deck shelter in stormy weather. The *Winchester* has two stacks, oval in shape and of large size, one signal mast, and a complete equipment of launches and boats. She is to be painted black, and, with her striking and clean lines, will unquestionably look every inch what she is meant to be—namely, an express vessel of extreme speed and capable of maintaining this speed under adverse conditions with the greatest possible comfort and safety to those on board.

TURBINE EXPRESS YACHT WINCHESTER

While the propelling machinery occupies a very considerable proportion of the interior, the owner has unusually comfortable accommodation for himself and guests aft, so that he can make extended cruises in comfort; and the fuel supply being large, the customary annoyance of frequent coaling, which is essential in all coal-burning vessels of this type, will be obviated. The raised forecastle is taken advantage of to form most comfortable quarters for the officers, below which is the regular forecastle with berthing and messing spaces for the crew.

Mr. Rouss is to be congratulated upon his perseverance in the development of the express steam yacht, the present *Winchester* being the third of that name built for him within the past five years. The first *Winchester,* now called the *Adroit,* was sold by Messrs. Cox & Stevens to Mr. Alfred Vanderbilt, and immediately on her sale Mr. Rouss entrusted this firm of architects with the placing of the order for the second *Winchester,* which was the first oil-burning turbine express steam yacht ever built. Last fall Mr. Rouss, having had such a satisfactory experience with the second *Winchester,* and being desirous of owning a larger and faster vessel of the same type, commissioned Messrs. Cox & Stevens to sell the second *Winchester* and to design and have built a new vessel, the result of which is the new *Winchester.*

Trial Trip of a Steel Screw Steamer

On March 4 the steamship *Atlantic City,* built by Messrs. Ropner & Sons, Ltd., of Stockton-on-Tees, made her official trial trip in the Tees Bay. The steamer has been built to 100 A1 Lloyds, and is for the Bradford Steamship Company, Ltd., Cardiff (Messrs. W. R. Smith & Son, managers). She is about 392 feet long and has a deadweight carrying capacity of about 7,900 tons. The accommodation for captain, officers and engineers is in houses on the bridge deck, with the crew in the forecastle. The engines are of the triple-expansion type, of about 1,900 indicated horsepower, by Messrs. Blair & Company, Ltd., of Stockton-on-Tees.

The vessel has been built under the superintendence of Capt. J. H. Smith, and on trial attained a speed of over 11 knots. She is particularly well equipped with cargo-handling gear of the most improved type for the loading and discharge of heavy cargoes.

Economy Due to Superheated Steam in Marine Practice

BY WALTER M. McFARLAND *

The theoretical advantages of the use of superheated steam were evident at an early date, as indeed would be inevitable when the principle of the Carnot heat cycle was understood. In the early days, when materials were not nearly so good as at present, and steam pressures were accordingly much lower, the benefit of getting the economy due to a very much higher initial temperature with no increase of pressure was, of course, obvious. Accordingly, very many experiments were made and a number of plants were installed using superheated steam, often with special superheating boilers. On the whole, these early installations were not practical successes, on account of the rapid corrosion of the superheaters, although the heat economy was obtained. In those days workmanship was not so good as now, and the causes of corrosion were not only not properly understood but there was dense ignorance concerning them, so that the measures taken to prevent corrosion really increased it. Obviously, there was no commercial economy in a system where the cost of repairs far exceeded the saving due to increased thermal economy.

In more recent years, since corrosion has been better understood and the means for preventing it are fairly well known, the attractiveness of the benefit to be derived from superheating has led to its reintroduction, and this article is intended to be a brief discussion, with some illustrative examples, of the economy which comes from the use of superheat.

In land installations, where poppet valves can be used, so that the question of valve friction does not come up, superheat may be used to almost any degree that is desired, and there are a great many examples of such engines on the Continent of Europe which are working with a remarkable degree of economy, in some cases very closely approaching 1 pound of coal per horsepower-hour.

With the steam turbine, where there are no rubbing surfaces, the benefit to be derived from superheat was at once apparent, and, generally speaking, it may be said that all the large power houses and central stations which use steam turbines also use superheat. In these cases there is not only the thermal economy due to superheat, but it has been found that the dry steam has much less erosive action on the blades of the turbines than steam which is moist. An excellent article by Capt. C. A. Carr, U. S. N., published in the *Journal* of the American Society of Naval Engineers for February, 1911, gives a great deal of information with respect to these land plants, and will repay very careful study. Speaking generally, it is considered that with steam turbines of modern design and carrying from 175 to 200 pounds of steam pressure, there is a saving in steam consumption of about 1 percent for each 10 degrees of superheat.

About ten years ago, Capt. Augustus B. Wolvin, then the manager of a number of steamboat lines on the Great Lakes, and who has been one of the poineers in the adoption of improvements in marine machinery tending to economy, installed Babcock & Wilcox boilers and superheaters in one of the vessels under his control, and followed this by similar installations on several other vessels. One of these, the *James C. Wallace,* was subjected to a test by a board of naval engineer officers, and showed a saving in coal of about 9 percent, with an average superheat at the engine of about 85 degrees. The Bureau of Steam Engineering took up this subject, and in 1904 ordered Babcock & Wilcox boilers and superheaters to replace the old cylindrical boilers on the *Indiana.* This was followed by installations of similar boilers and superheaters on the *Massachusetts* and the *New York* (now *Saratoga*) in the way of replacements, and on the *Michigan, South Carolina, Prometheus, Vestal, Delaware, North Dakota, Texas* and *New York* (new), new vessels. In 1905 boilers and superheaters from the same makers were ordered for the steamship *Creole,* with respect to whose performance some interesting data will be given later on. The Pennsylvania Railroad, in its marine service, has always shown a desire to get the safest and most efficient machinery, and in 1909 ordered from this concern boilers and superheaters for three of their large tugs, the *Johnstown, Wilmington* and *Harrisburg,* which have given great satisfaction and economy in service. The steam yacht *Idalia* also has a boiler and superheater supplied by this same firm.

It will thus be seen that superheat is in use on a large number of vessels, and undoubtedly a great deal of experience has been accumulated, but, unfortunately, not very much has been published.

TABLE I.—ECONOMY DUE TO SUPERHEATED STEAM—MERCHANT VESSELS.

Name of vessel	Creole.	Momus and Antilles.
Date of tests	1910	1908–9–10
Length, feet	407	410
Beam, feet	53	53
Draft, feet	26.7	25.6
Tonnage, gross	6,754	6,878
Tonnage, net	4,302	4,326
Cylinders, diameter and stroke	(2) 27¾, 46½, 79, 42	(1) 34, 57, 104, 63
I. H. P.	7,000	7,500
Boiler pressure, pounds	210	210
Kind of boilers	Babcock & Wilcox, with superheaters.	Scotch, no superheater.
Ratio of superheating to evaporating surface, percent	1 to 15.5	.....
*Av. coal per trip for five round trips, tons	1,149	1,374
Percentage of saving by use of B. & W. boiler and superheater	†16.38	.....
Av. coal per trip for two round trips, each vessel, in October, 1910	1,206	1,461
Percentage of saving by use of B. & W. boiler and superheater	†17.45	.....

*The *Creole's* trips were in summer of 1910; those of the other ships are their most economical trips in summers of 1908, '09 and '10.

†The improved economy is due partly to greater efficiency of boiler of *Creole* and partly to superheat. See text for analysis and discussion.

Table I. gives the performance of the steamship *Creole,* which is fitted with Babcock & Wilcox boilers and superheaters, as compared with the performance of her two sister ships, the *Momus* and *Antilles,* which have ordinary cylindrical boilers without superheat. As shown by the table, the hulls are practically identical. The *Creole* has twin screw engines of about 7,000 horsepower, while the *Momus* and *Antilles* have single screw engines of about 7,500 horsepower. All three ships carry about the same steam pressure—about 210 pounds. The *Creole* was originally fitted with Curtis turbines, but the speed was too low (15½ knots) to permit economical use and they were removed. It is to be noted that so far as there is any advantage in engine economy it should be with the *Momus* and *Antilles,* which have each a single engine of about the same power as the aggregate of the two engines on the *Creole,* thereby reducing the losses due to cylinder condensation. The engines are all triple expansion and of excellent design. The *Creole's* first trip with her new engines was made in the spring of 1910. Two comparisons are given, one of five round trips of the *Creole* in the summer of 1910, as compared with five round trips of each of the others, obtained by taking their best performances in the three summers of 1908, 1909 and 1910. The second comparison is between two round trips of all three vessels made in the

* With the Babcock & Wilcox Company, New York.

month of October, 1910. They run over the same route from New York to New Orleans, and, as the hulls are identical and the engines designed and built by the same firm, the only material difference is in the boilers and superheat. The table shows that the *Creole* operates with about 17 percent less fuel per round trip than her sister ships. The average superheat carried is about 60 degrees, from which a saving of about 6 percent would be expected. It is to be noted, however, that there is a distinct gain in economy due to the use of the Babcock & Wilcox boiler, as contrasted with the cylindrical or Scotch boiler.

In an article by the late Admiral George W. Melville, U. S. N., published in the *Engineering Magazine* for January, 1912, are given reports of very accurate tests of Scotch boilers and of Babcock & Wilcox boilers, made by boards of navy officers and committees of independent engineers, so that the reliability of the data is beyond question. These tests showed that, at the rate of combustion obtaining in these vessels, the Babcock & Wilcox boiler shows an efficiency of about 74 percent, as against from 62 to 67 percent (average 64.5 percent) for the Scotch boiler. Working out the saving due to this greater efficiency, it comes to 11.7 percent, and this subtracted from 17.45 percent, the total saving, leaves 5.75 percent as the saving due to superheat, which agrees quite well with the rough general rule of 1 percent saving for each 10 degrees of superheat.

Table II. gives the performance of four United States navy vessels, all of the same displacement and approximately the same power, and all fitted with Babcock & Wilcox boilers. The *Kansas* and the *New Hampshire* have no superheaters, while the *Michigan* and the *South Carolina* are fitted with superheaters. The performance of these four ships is very interesting, showing a saving, based on the average of the two ships with superheaters as contrasted with the two without, of 18.52 percent. In this connection it is interesting to note the remarks of Commander Henry C. Dinger, U. S. N., formerly editor of the *Journal of the American Society of Naval Engineers,* who wrote the account of the trial of the *South Carolina,* and who says with respect to the better performance of the ships with superheaters:

"The engines of the *Michigan* and *South Carolina* represent a decided advance in economy of steam consumption of navy reciprocating engines. The design embodies the use of (1) superheated steam; (2) large ratio of cylinders, namely, $\frac{H.P.}{L.P.} = \frac{1}{10}$, and (3) a considerable reduction of cylinder clearance. Calculations from indicator cards indicate that the steam consumption at full power was about 12.6 pounds of water per indicated horsepower. This result may be considered as being within a few percent of the actual consumption. This shows a gain of about 16 percent over previous navy practice; of this gain one-half may be assigned to the use of superheated steam, and the other half due to the reduction of clearance and better cylinder proportions."

The dimensions of cylinders of all four ships are given in the table.

In October, 1909, a test was made of the machinery of the yacht *Idalia* with superheated steam by Dr. D. S. Jacobus, and witnessed and reported by Lieut. John Halligan, Jr., U. S. N. The owner of the *Idalia* is an accomplished engineer, which insures the maintenance of the machinery in first-class condition at all times. She has a four-cylinder triple-expansion engine, the cylinder diameters being 11.5 inches, 19 inches, (2) 22.7 inches by 18 inches stroke. All the cylinders are unjacketed and have piston valves. There is one Babcock & Wilcox boiler, with 65 square feet of grate surface and 2,500 square feet of evaporating surface and 340 square feet of superheating surface. These tests are notable from the fact that the weight of the steam used was carefully determined by weighing the steam condensed in tanks on carefully standardized platform scales. The actual duration of the test in each case was about two and a half to three hours, but observations were made every fifteen minutes. The well-known reputation of Dr. Jacobus as an experimenter insures the accuracy of the results, which are given in Table III. The duration of the experiments was obviously too short to make it worth while to attempt to measure the coal. It is to be noted that the feed, air and circulating pumps, all of which are independent, discharge their exhaust steam into the main condenser, so that the figures given for steam per horsepower include the steam used by these auxiliaries, as well as by the main engine, while the horsepower is of the main engine only. This is mentioned in order that the results, which might otherwise be considered rather high, may be thoroughly understood.

We have now given such experimental data as are available of measurements of coal and water to show the economy of superheating, and, as stated above, they bear out the rough rule that there is about 1 percent in saving of fuel for each 10 degrees of superheat.

The practical effect of superheated steam is, of course, to give a greater thermal efficiency to the engine in which it is used and reduce the number of pounds of steam required per

TABLE II.—ECONOMY DUE TO SUPERHEATED STEAM. OFFICIAL TRIALS OF UNITED STATES NAVAL VESSELS.

Name of Vessel	Kansas.	New Hampshire.	Michigan.	South Carolina.
Builders	New York Shipbuilding Co.	New York Shipbuilding Co.	New York Shipbuilding Co.	Wm. Cramp & Son S. & E. B. Co.
Date of trial	Dec. 14, 1906.	Dec. 20, 1907.	June 10, 1909.	August 25, 1909.
Displacement on trial, tons	16,000	16,145	16,064	16,064
Twin screw engines, diameter and stroke of cylinders, inches	32½, 53, (2) 61; 48	32½, 53, (2) 61; 48	32, 52, (2) 72; 48	32, 52, (2) 72; 48
Kind of boilers	Babcock & Wilcox.	Babcock & Wilcox.	Babcock & Wilcox.	Babcock & Wilcox.
Evaporating surface in use, square feet	52,752	47,112	42,432	42,432
Superheating surface in use, square feet	No superheaters.	No superheaters.	5,174	5,174
Ratio superheating to evaporating surface, percent	.....	.....	12.2	12.2
Heating surface, total square feet	52,752	47,112	47,606	47,606
Grate surface, total square feet	1,097	1,100	1,046	1,046
Ratio evaporating to grate surface	48.0 to 1	42.81 to 1	40.6 to 1	40.6 to 1
Speed, average for trial (4 hours)	18.004	18.162	18.79	18.86
Revolutions, average per minute (4 hours)	121.32	118.75	119.46	121.28
Steam pressure at boilers, gage, pounds	278.2	246.00	297.70	285.00
Steam pressure at high-pressure steam chest, gage, pounds	250.0	222.00	246.00	241.00
Steam pressure, first receiver, absolute, pounds	106.5	93.00	77.40	96.50
Steam pressure, second receiver, absolute, pounds	38.0	32.20	8.10	35.10
Vacuum in condensers, inches of mercury	28.0	25.60	27.00	26.2
Superheat at high-pressure chest, degrees Fahrenheit	None.	None.	85.70	47.5
I. H. P. of main engines only	19,302.00	16,772.00	16,016.45	17,651.00
I. H. P. of all auxiliaries in use	455.00	495.00	500.85	706.00
I. H. P. total	19,757.00	17,267.00	16,517.30	18,357.00
Coal per hour per I. H. P. of main engines	1.779	1.785	1.51	1.395
Coal per hour per I. H. P. of main engines and all auxiliaries	1.737	1.773	1.46	1.341
Coal per hour per square foot grate surface	31.21	27.21	23.28	23.47
Air pressure in fire rooms, inches of water	0.60	0.49	0.67	0.78

TABLE III.—ECONOMY OF SUPERHEATED STEAM. TESTS ON YACHT IDALIA. SUMMARY OF TESTS.

Date, 1909.	Conditions.	Pressures.			Vacuum.	Temperatures.		R. P. M.		Revolutions per Minute, Main Engine.	I. H. P., Main Engine.	Water per Hour, Total.	Water per I. H. P.	Percent Saving of Steam.
		Throttle.	First Receiver.	Second Receiver.		Feed.	Hotwell.	Air Pump.	Circulating Pump.					
Oct. 11....	Saturated.....	190	68.4	9.7	25.5	201	116.0	57	196	194.3	512.3	9,397	18.3	.....
Oct. 14....	Superheat, 57°...	196	66.0	9.2	25.9	206	109.5	56	198	1 1.5	495.2	8,430	17 0	7.10
Oct. 14....	Superheat, 88°...	201	64.3	8.7	25.9	205	115.0	53	196	195.1	521.1	8,234	15.8	13.66
Oct. 12....	Superheat, 96°...	198	61.9	7.8	25.4	202	111.5	54	198	191.5	498.3	7,902	15.8	13.66
Oct. 13....	Superheat, 105°..	203	63.0	8.4	25.2	200	111.0	45	197	193.1	502.2	7,790	15.5	15.30

horsepower. The question has frequently been raised whether there is a corresponding saving in fuel. That is, will not the fact that a pound of superheated steam contains more thermal units than a pound of saturated steam require in the long run a greater expenditure of fuel per pound of steam, so that, although fewer pounds of steam are used per horsepower, it takes a greater amount of coal for a given number of pounds of water evaporated? Speaking generally, it may be asserted that with superheaters properly designed and located, and within the limit of superheat ordinarily used in marine practice—50 to 100 degrees—such tests as have been made, and such general experience as has been gained, tend to show that there is in the long run practically no increase in the fuel per pound of steam, or, in other words, there would be almost exactly the same percentage of reduction in the amount of fuel used as in the amount of steam per horsepower. It is not difficult to understand why this should be the case in a properly designed arrangement of superheaters. In all the cases cited, and which are the only ones for which data are available, the superheaters are used with Babcock & Wilcox boilers. As is well known, a system of baffling is used in these boilers which causes the hot gases to cross the tubes three times on their way from the furnace to the up-take. The superheaters are placed at the passage from the first to the second pass, after the gases have crossed the tubes once and before they cross the second time, so that the temperature is very much higher than in the case of the older types of superheaters, where they were placed in the up-take like a feed-water heater. The experiments which have been made on these boilers under various rates of combustion show that the temperatures where the superheater is located, when burning from 30 to 35 pounds of coal per square feet of grate, would be about 1,000 degrees F., while the temperature of saturated steam of about 200 pounds is about 388 degrees F. There is thus a good difference in temperature, so that a considerable degree of superheat is obtained with a moderate amount of superheating surface. There are still the second and third passes of the boiler to be acted upon by the hot gases, and the only effect is to reduce slightly the temperature of the gases in the up-take. In other words, the efficiency of boiler and superheater is at least as great as that of the boiler alone.

The examples we have given of the navy vessels, of the *Creole* and her sister ships, and the *Wallace*, with and without superheat, all show results as measured in coal, while the *Idalia* experiments give them in water. None of these experiments has the conditions absolutely ideal for determining with extreme accuracy the exact amount of gain due to superheating, because other items vary besides the extent of superheat. What practical men desire to know, however, is not results to the last decimal point, but to be reasonably sure that there is a decided gain due to superheating, and this, we think, has, from the data given, been shown beyond controversy.

We have already mentioned one of the benefits which has been found in land service where superheated steam is used with turbines, and, obviously, thoroughly dry steam, as against very moist, would be a blessing in reciprocating engines, so that this, of course, is another benefit of superheating. On board ship, where there are so many auxiliary engines scattered over a large area, and many of them simple cylinders following full stroke, it can readily be seen that the use of superheated steam ought to be conducive to a great increase of economy. Unfortunately, if tests of this kind have ever been made by the Navy Department they have not been published.

It now remains to mention some of the drawbacks, or rather matters which have to be attended to, if the use of superheated steam is to be entirely satisfactory. In the central stations and power houses on shore, before the use of superheated steam, many of the valves and fittings in the pipe lines were of cast iron. It was found that superheat of 100 degrees, or higher, caused considerable trouble, due to distortion of the cast iron fittings and inability to keep the valves tight. The general practice now is to avoid the use of brass or cast iron, and the valve bodies and fittings which come in contact with superheated steam are to be of cast steel. Valve seats are made of bronze with a large percentage of nickel or of Monel metal, which is a natural bronze of somewhat similar composition. The navy is now using Monel metal valves and seats. With these precautions, experience has shown that superheated steam up to 100 degrees can be used with great satisfaction as far as practical service is concerned, with no increased cost of repairs and with the decided increase in thermal efficiency which has already been mentioned, and which is so essential in all kinds of naval and merchant marine machinery.

The Department of Naval Architecture and Marine Engineering of the Massachusetts Institute of Technology has just received a gift of $750,000 (£154,000) bequeathed by the late Mr. C. H. Pratt, of Boston. This sum will be available for expenditure in two or three years, and according to the terms of the donor's will it is to be used for the purpose of founding or endowing at the Institute the Pratt School of Naval Architecture and Marine Engineering. This gift, coming unsolicited from an unexpected source, is a fitting recognition of the importance which the Department of Naval Architecture and Marine Engineering at the Massachusetts Institute of Technology under the directorship of Prof. C. H. Peabody holds in the world of engineering. This school has constantly attracted students from a great many nations in different parts of the world, which are seeking to establish the industry of shipbuilding. It is the official school for the instruction of the United States naval constructors.

The American Museum of Safety, 29 West Thirty-ninth street, New York, announces that Judge Albert H. Gary, on behalf of the United States Steel Corporation, has presented the museum with $5,000 (£1,023) for obtaining a collection of the best devices for saving life at sea, as a permanent exhibit for demonstration free to the public.

French Destroyer Dague

The French Admiralty is somewhat proud of the successful results obtained with the new destroyer *Dague,* recently built by the Gironde Works, Bordeaux. This destroyer has the following dimensions.

Length over all	255 feet 11 inches
Length between perpendiculars	251 feet 1 inch
Beam	26 feet 1 inch
Beam at load waterline	25 feet 10 inches
Depth	16 feet 9 inches
Draft at the stern	9 feet 8 inches
Trial displacement	730 tons
Full load displacement	770 tons

The hull was designed by the Gironde Works, and the turbines supplied by the Brequet firm, which is one of the two builders of marine turbines under French patents. The hull is divided into ten watertight compartments. She has a high freeboard forward, where there is a forecastle deck, which insures better seaworthy qualities than previous types of the destroyers built for the French navy.

Steam is supplied to the main and auxiliary engines by four du Temple watertube boilers, the heating surface of the boilers being 10,668 square feet. Liquid fuel is used, and each boiler has eleven Thornycroft burners. They deliver the fuel under a pressure of 143 pounds per square inch. Thornycroft fuel heaters are also used. The working pressure of the boilers is 173 pounds.

The main engines consist of two independent sets of Brequet turbines, each driving a separate shaft. In each casing are located an ahead and an astern turbine. They have been designed to develop an average of 1,500 shaft horsepower at a speed of 630 revolutions per minute. The contracted speed of the vessel was 31 knots, but during the trials a speed of 33.118 knots was attained. The Brequet turbines are of the impulse type. The power of the steam acting on the blades is balanced by the propeller thrust, any difference between the two being taken up by a small thrust bearing. Each turbine drives a single three-bladed propeller, 7 feet 1 inch in diameter and 6 feet 7 inches pitch.

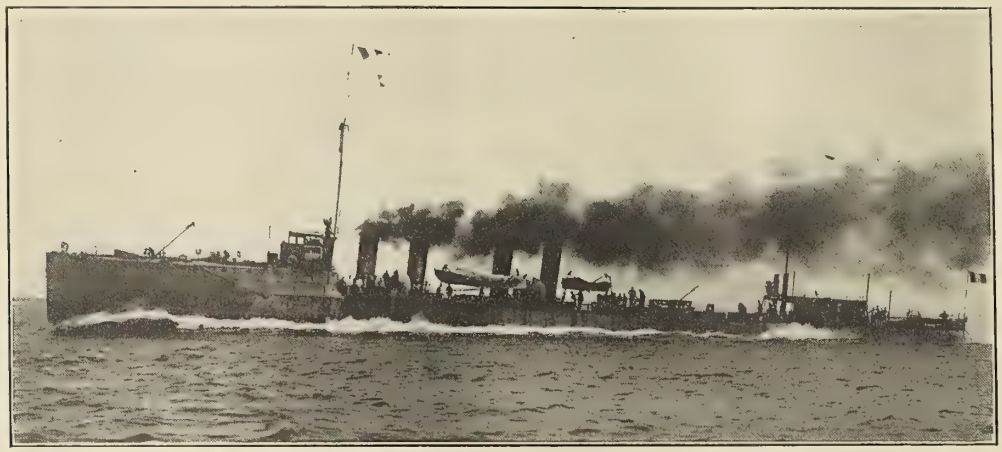
Each turbine has its own independent condenser, with a total surface of 27,340 square feet. The fuel is carried in the double-bottom and longitudinal tanks on both sides of the boiler rooms. The total capacity of the tanks is 5,700 cubic feet, which gives a theoretical steaming radius of 2,060 miles.

The armament consists of two quick-firing 4-inch guns located forward and aft and four 18-inch torpedo tubes.

Results of Official Trials

Six Hours' Duration Trial.—Displacement before trial, 733 tons; draft at the stern, 9 feet 8 inches; number of boilers at work, 4; steam pressure at the boilers, 214 pounds; steam pressure at the turbines, 200 pounds; air pressure, 7.6 inches; oil pressure at the burners, 142 pounds; number of revolutions, 667; contract speed, 31 knots; mean speed for six hours, 33.118 knots; oil consumption as per contract, 12.50 tons; oil consumption on trials, 11.15 tons; consumption per square foot of heating surface, 1.22 pounds; miles per ton of fuel, 2.83.

Eight Hours' Consumption Trial at 14 Knots.—Displacement before trial, 734 tons; draft at the stern, 9 feet 8 inches; number of boilers at work, 2; steam pressure at the boilers, 200 pounds; air pressure, 1.16 inches; pressure of oil at the burner, 58 pounds; number of revolutions, 244.16; speed as per contract, 14 knots; speed on trial, 14.3 knots; consumption per hour, 1.03 tons; consumption per square foot heating surface, .02 pound; miles per ton of fuel, 14.



NEW FRENCH DETROYER DAGUE

Hydraulic Dredge for Canal Digging

A 15-inch hydraulic dredge was recently designed and built by the Norbom Engineering Co., of Philadelphia, Pa., for Champion & Co., Havana, Cuba, for general contract work and canal digging. It was principally intended to cut out the Roque drainage canal, and on account of the very shallow waters encountered at different places, the hull had to be made very large, compared with the size of the machinery outfit—viz.: with a draft of 34 inches.

AN AMERICAN-BUILT CANAL DIGGER IN CUBA

The main centrifugal pump on this dredge was made in steel throughout, without any other liners than a throat ring, a design which was considered the best under the circumstances. It is direct connected to a compound condensing en-

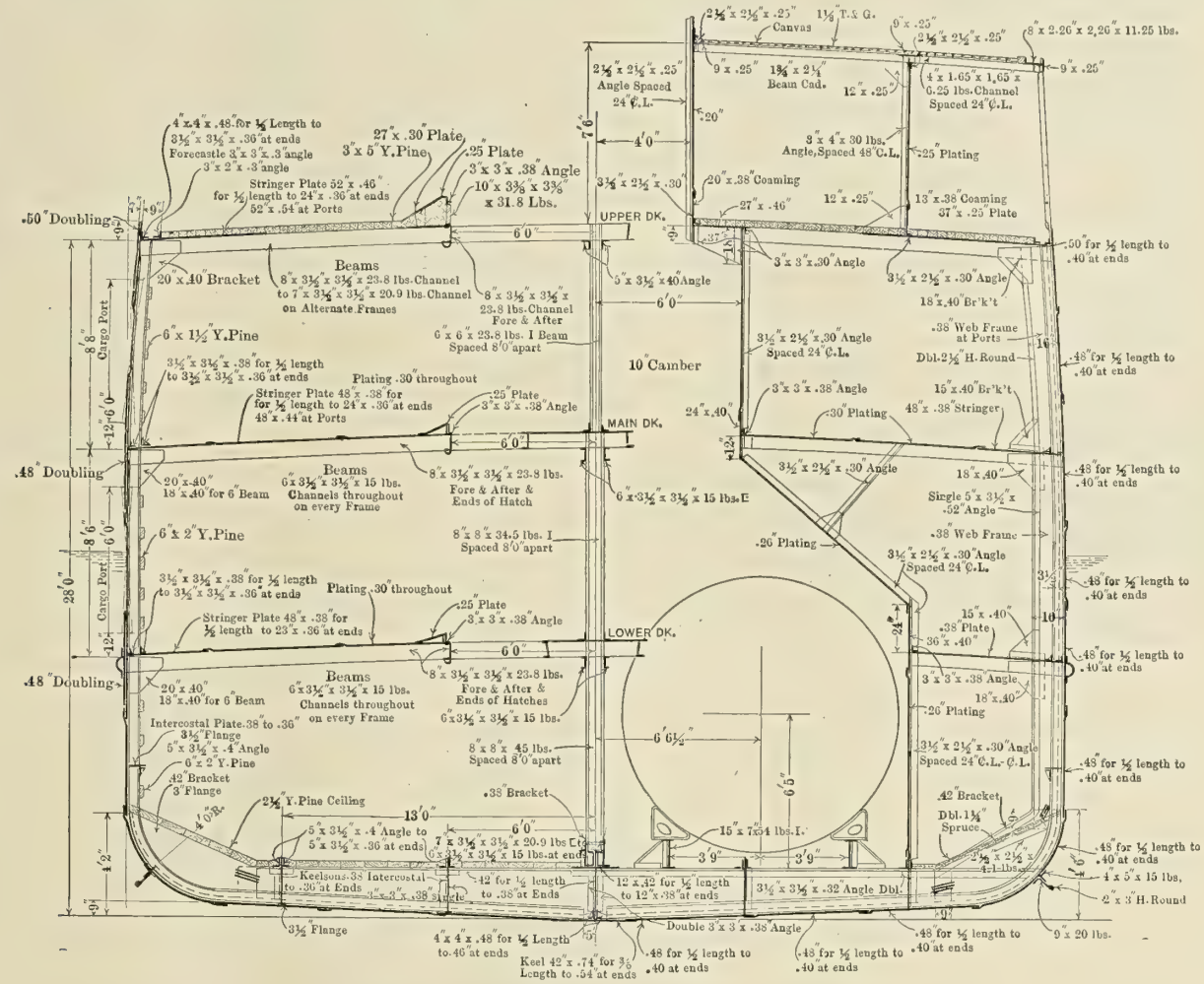
gine, with cylinders 12 inches and 25 inches diameter and 14 inches stroke, using steam at over 150 pounds pressure and working under a vacuum of 25 inches.

The atmospheric conditions characteristic for the Cuban and other Southern climates made it almost impractical to use the boilers with natural draft without an exceedingly high stack, and for this reason the dredge was fitted with a blower engine for induced draft. This accounts for the short smoke stack shown in the picture.

The ladder is of structural steel construction designed for the most severe service, and is self-contained, in that all gearing, as well as the cutter engine, is mounted on the ladder.

Steamship Henry Williams

The steel screw steamship *Henry Williams,* built by the Harlan & Hollingsworth Corporation, of Wilmington, Del., for the Baltimore & Carolina Steamship Company, was launched on April 2. The vessel is built of steel throughout, and is of the awning deck type, having complete steel main and lower deck, while the awning deck is sheathed with wood. She has a straight stem and elliptical stern, and is rigged as a two-masted schooner, having a steel deck house for officers amidships around the engine and boiler enclosures, the latter being of steel. The crew's quarters are located in the fore-



MIDSHIP SECTION OF FREIGHT STEAMER HENRY WILLIAMS

The engine, which is of a special construction for this class of work, runs fore and aft with the crankshaft athwartship, thus obviating the objectionable features incident to setting the engines athwartship with the crossheads and other reciprocating parts wearing sideways.

This dredge was built in a remarkably short time, considering the fact that the hull had to be built in a locality that was about 30 miles from the nearest railroad, and all machinery and material had to be transported over the poorest kind of roads by ox teams. The contract for the machinery and fittings was placed with the Norbom Engineering Co. in the latter part of June, 1911, and the dredge commenced operations in Cuba on December 23.

With a new crew, most of whom knew little of dredging operations, the dredge is making an average output of about 2,800 cubic yards per day, a performance which was most remarkable, considering the nature of the material, the specific gravity of which averaged 2.3 to 2.6.

castle. There are four hatches on the main and lower decks, and one hatch and also an over-all hatch on the awning deck. There are two cargo ports through both sides between the upper and main decks, and two cargo ports through both sides between the main and lower decks, also over-all ports and a hatch with wood covers.

The dimensions of the vessel are as follows: 241 feet long over all, 230 feet between perpendiculars, 229 feet 6 inches Lloyd's perpendiculars, 39 feet beam, molded, 28 feet depth, molded, clear headroom between decks 8 feet. She has been designed for freight service only, and will carry 1,500 tons on a draft of 15 feet.

The propelling machinery consists of a single triple-expansion engine, having cylinders 17 inches, 27 inches and 44 inches diameter, with a stroke of 30 inches, steam being supplied by two cylindrical return tube boilers, 11 feet 3 inches diameter by 10 feet 9 inches long, working at a pressure of 180 pounds per square inch.

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

A Peculiar Mishap

Carelessness in handling the overboard discharge, according to unofficial statements, was the cause of a peculiar mishap which sent the freight steamer *Tampico,* of 1,451 tons net, to the bottom of the Seattle harbor recently. At the time the *Tampico* was loading her bunkers. As her stern went down she began to fill and the united efforts of her pumps were unable to stop the inflow. Aid was summoned, but sufficient pump capacity could not be secured to stop the

STEAMER TAMPICO SUBMERGED IN SEATTLE HARBOR

intake, and as the water rose it soon covered the *Tampico's* furnaces, extinguishing the fires. By this time it was seen that nothing could prevent the vessel's sinking, and consequently she was towed a short distance away, where she gradually settled in about 30 feet of water, only a short distance from shore and in the center of the harbor. Difficulty was experienced in salving the ship and extensive repairs were necessary on account of damage to the hull.

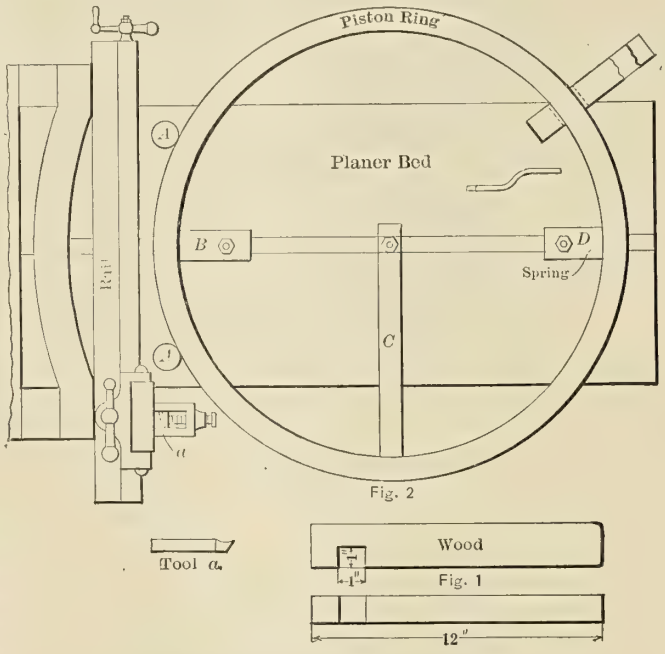
Seattle, Wash. R. C. HILL.

A Piston Ring Planer Job

The other piece I wrote for you got me into a lot of trouble. I was proud as the captain's parrot when it catches a lizard when I got the copy of INTERNATIONAL MARINE ENGINEERING and saw what I wrote all in print, and I read it over to our "third," who is a Scotchman, and who is the only one I guess in the world—they are generally firsts. He would be, too, if he didn't patronize the "boozitoriums" so much when he goes ashore. He said it was "main fine"; but when he saw the sketch we had words, and I had to punch him until he said "'nough," and I got fined a week's pay. You people must be dandy draftsmen to do work like that!

Our chief ain't a Scotchman but a Portugueser, and he is as good as goes, and weighs close on to 200 pounds, and speaks English kinder small, but he is all right. I guess if he had lived back some years he would not have been an engineer but some other kind of a pirate.

What I was going to tell you about was our fitting new rings in the intermediate. We had trouble with the intermediate rings, and the chief told me to get out the spares while he was getting the cylinder head off, when we next got into port, and as soon as we did I looked up the rings. There were four of them. But as soon as I took a look at them I saw we were in a fix, because they were finished outside and inside and one edge all right but the other edge was rough—left just as it had been cut off. Well, to file up a ring like that didn't promise a very good job, so back I goes to the chief and tells him, so he wouldn't break the joint on the intermediate. But he said, "It is goot so, we turn them



PISTON RING MOUNTED ON THE PLANER

up ourselves." I thought the sun had got into his head, but I just nodded and went after the rings again, and on my way met the "third," and told him about it, and he said, "Mon, alive! has he took to drink?" We had a dinky little lathe aboard, about 14-inch swing, a small drill press and an old-fashioned planer with a bed about 18 inches wide and 36 inches long. When I got back with the rings the chief had got the cylinder opened up; he took the rings and looked them over, and pointed to something I never saw before. It was a space on the edge of the ring stamped with a steel stamp, "cut this piece out," with two slanting marks on each side of this. Now, that was first-class, as you knew just what you had to cut out to make the rings butt up nice together. I wish other people did this, too.

Back of these snap rings there was a sort of corrugated strip of spring steel. Now, what the chief did was to get the carpenter to make a wood piece out of some good, hard stuff like my drawing, Fig. 1. You bet I didn't ask any questions, but just kept looking on to see how he would turn up a 20-inch ring on a 14-inch dinky little lathe; but he didn't try. He made two studs and put them in the planer bed about like my sketch, Fig. 2, at *A, A;* then he made a stop like *B,*

and another one like *C*, and a light spring like *D*. He took a planer tool and annealed it and planed it off on the edge, so it would go into the planer tool post and have the cutting edge point across ship instead of fore and aft. When he got all these things ready he laid the ring down on its good side, as shown in my sketch, on the bed, and brought it up against the plugs *A* and *A;* then he brought up the strap *B* just so as to hold the ring without shaking and not let it bind; then he bolted it up fast. He did the same with the long stop *C;* he had made the ends of these nice and smooth with a file; then he tightened up on the spring *D* just enough to feel, and I kept watching him with a bunch of waste in my hand and an oil can handy.

By this time the "third" had brought up the tool which he had been hardening, and he stood by. The chief took the tool and put it in the post, and hooked over the piece of wood on the ring about as shown in the drawing. Then he put the tool into the post and brought it over by the cross feed until it stood about at *A;* then he worked the bed back until the edge of the tool, if fed across, would cut a little beyond the inside of the ring; then he lowered away on the tool; at the same time he gave a pull on the wooden handle, and, of course, this turned the ring and kept feeding down till the tool just began to cut; then he kept yanking on the wooden handle, pulling the ring around and around, and, of course, the tool took a chip all around the ring.

By feeding across he pretty soon got a good, smooth cut on the ring. I caught on to the idea and so did the "third" right off, and he gave me the other rings to do, and I made a good job of them. They only needed a little scraping, after we had sawed out the piece, to jump them over the piston, and that finished our trouble.

Now, my dear Mr. Editor, for the Lord's sake don't make my drawing look so nice, or that "third" and I will mix it up again, and I got my suspicions that he and the first water tender are practicing sparring, and I had all I could do the last time with him and now he is letting booze alone, so no more at present. TROUBLE.

The Presence of Salt in Water

The use of the salinometer is, of course, a necessity well known to every sea-going engineer. But it is a matter of considerable importance and interest to know, when working with quite fresh water in the boilers, if any sea water gets introduced. The ordinary salinometer test is, not to say the least of it, a delicate one, and is only approximate for a small quantity of salt. Tasting is a rough and ready method, but I am afraid we are not all fitted with sensitive palates.

One gallon of sea water contains 6 ounces of solids, and this shows as 1/32 on the salinometer. That is, a single division on scale represents 3½ percent, so that the instrument cannot be considered quantitative in a chemical sense.

A test that will infallibly detect the presence of 15 grains of impurity per gallon, *i. e.*, one part in 4,700, or .02 percent, is by using nitrate of silver. To one ounce of suspected water add 2 drops of nitric acid; stir, add 1 drop nitrate of silver. If salt is present, there will be a white precipitate, which will darken on exposure to light.

A recent analysis of sea water gave: Chloride of sodium, 2.60 percent; chloride of potassium, .07 percent; chloride of magnesium, .28 percent; sulphate of lime, .11 percent; sulphate of magnesia, .26 percent.

The insoluble scale is produced by the sulphate of lime, which deposits at 287 degrees Fahrenheit to 310 degrees Fahrenheit, equal to 30 to 35 pounds pressure. Chloride of magnesium decomposes at ordinary boiler temperatures, giving rise to active hydrochloric acid in the water. Light should be excluded from the bottle containing nitrate of silver.

London. A. L. HAAS.

Navigation Under Difficulties

In the accompanying unique photograph is shown a stern view of the steamer *Watson,* of the Alaska-Pacific Steamship Company, as it appeared when the *Watson* was hauled out in drydock at San Francisco after a harrowing experience while bound from Puget Sound with freight and passengers for San Francisco. En route the *Watson* ran into a terrific storm from the southwest, accompanied by an unusually high sea. Suddenly the rudder carried away and with it went the rudder post and skag. Whether a sea broke off this gear

DAMAGE TO STEAMER WATSON

or whether some submerged obstruction caused the damage is not known. However, the vessel was so skilfully maneuvered that there was no panic among the 100 passengers and the liner arrived safely at San Francisco, after steering 400 miles with the balance of the rudder. The vessel was drawing 18 feet at the time of the accident. The break in the rudder occurred at the 15-foot mark, so that the vessel was steered over 400 miles with but 3 feet of the rudder submerged. It required careful handling to do this, especially in the face of unusually bad weather. Capt. E. P. Bartlett and Chief Engineer Thomas McGrorey have been highly complimented by their owners for the splendid manner in which they did their work. Being equipped with wireless, news of the *Watson's* plight was sent ashore and tugs were awaiting the vessel to assist her through the heads at San Francisco harbor. She made her port only about twelve hours behind time. R. C. H.

A Preventative of Scale and Corrosion in Boilers

The question has occurred to me, why do so many of the brother engineers still persist in using strong chemicals to prevent internal corrosion and for the removal of scale from boilers? I have had a great deal of experience on land and at sea, and have found that chemicals that are strong enough to loosen and dissolve old scale will also attack the boiler itself. They will eat the flange packings in your steam line, destroy the piston rod packing and sometimes affect the rod itself. Now I had an experience some years ago which taught me a lesson. It taught me that there was a cheaper and more efficient way of removing scale and preventing same from forming than the use of strong chemicals.

We had just finished cleaning boilers after a lay-off of several weeks. I sent one of the firemen up over the tops of

the boilers to get a small bag of graphite. He let the bag drop on top of one of the boilers, spilling about half of the contents of the bag, or about 20 to 25 pounds, down through the manhole and into the boiler. I thought at the time that it could not hurt anything, so I did not bother to clean it out, but forgot the incident and did not think of it again until I had it brought to my mind four or five months later, when we opened up the boilers for cleaning again.

I went through two of the boilers and found them in about the same shape as before. In between some of the tubes the scale had formed in a solid mass. On the shell and crown sheets there was from 1/16 to ⅛ inch hard scale. I put a couple of men in each boiler to scale and clean them, and I went on to the next boiler. You can imagine my surprise when I went into No. 3 boiler (on the same battery using water from the same source) to find it almost entirely free from scale. What had settled in the bottom was soft and could be crushed in your hand. Most of it could be washed out with a hose. I did not know what to make of conditions as I found them until I came out with a handful of sediment I had gathered up as I came out. Upon examining this I found it was mixed with graphite, and then I remembered the incident when the graphite was spilled in the boiler.

I have used graphite ever since as a preventative of internal corrosion and to prevent the forming of scale. The graphite I have used has left the boilers clean and does not impair the boiler, packing or engines. No more chemicals for mine. A boiler graphite that protects boilers, engines, etc., is good enough for me. W. V. FORD.

Norwich, Conn.

Fitting a Combustion Chamber Patch

A small steam schooner came to port that was under charter to make a trip to Alaska. The local boiler inspector was to make the annual inspection of the boiler, which was fourteen years old. When they applied the hydrostatic pressure everything around the boiler proved to be tight, no leaks of any kind developing, although I might add that a few rivets were calked and some tubes rolled before the inspector looked it over.

Satisfied with this part, the boiler was emptied and drained out and a thorough inspection made inside, and, barring a very slight pitting, the boiler was in very good condition. The inspector then ordered a drill test of the boiler on the shell at the waterline and at the bottom of the boiler and in the bottom of the combustion chamber wrapper sheet. The first drill tests showed the original thickness, while the combustion chamber had thinned down from ⅝ inch original thickness to 5/16 inch in one place. This was all on the fire side, while the under or water side showed evidence of grooving. I attributed this condition to allowing wet ashes to accumulate in the bottom of the boiler while the boat was out of use.

The inspector ordered the working pressure of 135 pounds cut down to about 95 pounds, and, as they did not want to lose the charter, they asked for and received permission to patch the bad part, which job was immediately undertaken by the boiler shop. I went down to the boat and looked the job over, deciding to renew the bad section on the bottom, which extended 27 inches on each side of the bottom center and included cutting out forty-four 1⅜-inch stay bolts. I also decided that it would be easier to scarf each of the four corners of the old wrapper sheet than it would be to scarf the new plate and slip it under the old pieces, as we would not have to cut out an additional row of staybolts on each side or as many rivets. We would also do away with heating the patch in the corners, which would be very apt to crack the old plates. Deciding on this, I marked the piece to be cut out, and also marked a 2¾-inch by 5¾-inch hand hole on the back head opposite the two lines to be cut, the same to be used in cutting part of the old wrapper sheet, to pass rivets through, etc. I marked the plate allowing an extension for the scarf on each of the four corners.

In the meantime, we had an air line with a manifold, so as to hook on about four air hose lines, and an electric wire for portable lights installed aboard the boat. I started one boiler maker in the combustion chamber to cut across the width on each side, another on the back head to cut out the hand holes and the back end of the wrapper sheet, the first boiler maker going in the boiler under the furnaces and cutting the front ends. He then cut off all the rivet heads to be cut out inside the combustion chamber and backed the rivets out. We then started in to cut out the staybolts, as follows: We split the nuts with a coal chisel and button set and nicked the bolt close to the wrapper sheet, and hitting the bolt on the end a few hard blows with the button set they readily broke off. We then drilled each bolt about ¾ inch deep, or just through the wrapper sheet. We then got an extra long chisel bar that extended through the front manhole and broke the staybolts off close to the shell. This being done, it allowed the piece we had cut out to drop down, and by turning and twisting it around it was readily taken out of the furnace and up to the boiler shop, the furnace front being previously removed.

One boiler maker started in to scarf off the corners by chipping, while another started in to drill out the staybolt ends in the shell from inside the boiler. In the meantime, we had straightened the plate we had cut out, and, getting a plate of flange steel, we marked off a new piece by placing the old one on top and marking off all the old holes, leaving the new holes in the seam out, which holes were being drilled in the boiler. We then proceeded in the ordinary way to drill, plane and roll the plate, having made a sweep from the old piece before straightening. By this time the scarfing was all done on the boiler, and I made a templet of it on each of the four corners, as they were thinned down by chipping and varied slightly, and using a hole as a tell-tale point so as to have the pocket in just the right place.

We next had the plate taken to the fire, where we heated it and worked each corner to conform to the templets, already mentioned. In putting in these pockets we got a small steel wedge, which was just about the size of the scarfs on the old section. We did this work to save heating and fitting on the boiler.

Having drilled the seam holes and countersunk them, also all the holes in the heads, and having cleaned all the staybolt holes out, we placed the new plate in position, and after bolting it up and drilling the rivet holes through the seams and the ends in position we were ready to rivet it up, as it required no fitting or heating whatever. This was quite an item, as it would surely endanger cracking the old heads were we to heat the corners. The rivets were driven by hand with a deep countersink, the holder-on having quite a job reaching in under the back end, as he laid under the furnaces, where there was about 5 inches water space at the bottom. The job was calked on the combustion chamber side only.

We next put in the staybolts; the old ones were 1⅜ inches, but we put in 1½-inch bolts, as it is always better to put in a larger size on cutting out staybolts, as it is next to impossible to get good threads unless you do. We calked the bolts with a gouge-shaped calking tool, wrapped a couple of turns of asbestos string around it at the bottom, put a little red lead putty over that, and put the nuts on.

After thoroughly cleaning out the boiler, we closed it up again, and, filling with cold water, we applied the pressure. Everything being satisfactory, we sent for the inspector,

who, upon examining the work done, pronounced the boiler in good condition.

The old method of doing a job of this kind would be to scarf all four ends of the new plate, cut out four additional staybolts on each end and about twenty extra rivets, in order to spring the old wrapper sheet apart; then it would be necessary to heat and set up all four corners, and, at the best, you could not make a perfect job out of the back ones.

The above repairs were completed in 13 days (8½ hours per day), divided up as follows:

Four days cutting out the patch and forty-four staybolts.

Two days scarfing and trimming.

One day drilling.

Two days getting the patch out in the shop.

One and one-half days fitting the patch in place and drilling the seams.

Two days to rivet it up.

Two and one-half days tapping holes and putting in staybolts.

One day testing.

Plate was ⅝ inch by 30¾ inches by 60 inches; ⅞-inch rivets.

Average of three boiler makers and two helpers on the boat, all the work being done with air tools.

We, very shortly after completing this job, had a similar one on another steam schooner; but, in order to get at the staybolts on the bottom of the shell, we found it necessary to jack up the boiler, which involved quite a job of disconnecting steam pipes, etc. We did not cut the hand holes on the back head for this job, as we were able to cut out the old piece by using extra long chisels, having profited by the experience of the first job. JAMES VINCENT.

Crosshead Troubles

The cross-head shoes of marine engines do not generally give much trouble when the bearing surfaces are well oiled, nor do they require much attention. Formerly many cross-heads were fitted with brass shoes, but now, however, they are, as a rule, made of steel castings lined with white metal. This is quite satisfactory, yet the best results can be obtained by the use of cast iron, *i. e.*, cast iron running on cast iron. This construction requires more oil, but it wears less. At times cast iron will give trouble where white metal-lined shoes will not, as the following actual occurrence will show:

The cross-heads of the compound engine of the steamer *W*——— were made with cast iron shoes running on cast iron guide plates. On the trial trip the cross-heads warmed up and finally heated, and it was found impossible to cool them down by using a lubricant made of oil mixed with white lead, which is an excellent help in such cases, as most engineers know. They soon became so hot that sparks could be seen on the guide plate, and the engine had to be stopped. The shoes were taken off, which required considerable labor, as the cylinder head covers had to be taken off and the pistons unscrewed in order to reach the cross-heads. Several hard places showed on the shoes, which were scraped away. After all was again replaced the engine was started, and the trip completed, but the shoes gave the same trouble later.

It must be clear, therefore, that this form of cross-head is not the right one, as when it warms up even a little it will swell until it grips between the columns. When the shoes are lined with white metal on both sides they do not give this same trouble of gripping, but the wear is considerably more.

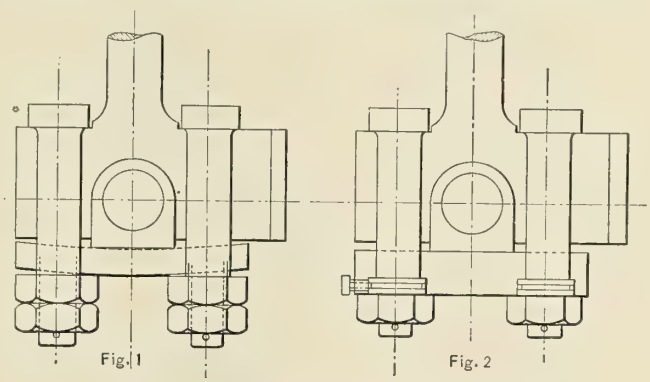
Often the astern shoe face is fitted with white metal lining and the go-ahead shoe is not. This seems to work very well. Cast iron on cast iron demands a larger surface and better oiling, but many engine builders object to its use, but this construction is not best in all cases, as the following will show:

The eccentric straps on an engine were not lined with white metal. On the trial trip of the vessel one of these gripped on the eccentric sheave, causing a breakdown. Here the surface is small. After this breakdown the builders of the engine always lined the eccentric straps with white metal.

It is often said that steel cast slippers running on cast iron guide plates give good results, and the writer knows several engines so designed and recommends this construction strongly. For naval and yacht engines all parts are, as a rule, made as light as possible. The stress on the bolts, etc., are generally higher in this class of work than on commercial engines. Even a few ounces in weight is saved, and it is often a source of discussion between designers of engines whether or not the hot wells, pipes and tanks and other receptacles for water are not made far too large for what is required, and too little attention is given to these causes of weight and superfluous amount of water to be carried.

Bolts are often made strong enough to resist the tensile strength, but this is not all that they, at times, have to be figured for. Other demands must be remembered, as is illustrated in the following:

One of the cross-head bolts of a yacht engine on the high-pressure cylinder broke. A new bolt was supplied, which again broke. Then two new bolts were made ⅛ inch thicker than the originals; but one of these soon broke, and a spare bolt was put in which held for some time, but when the bearing was taken up this bolt was found to be bent and had to be replaced. As in similar engines bolts of the same size were found to have held satisfactorily and gave no trouble it was clear that something must be the cause. It was suggested that water had been trapped in the high-pressure cylinder, causing excessive strains, and accounted for the breaking of the bolt; but the engineer investigated the matter carefully and found the cause of the mystery, which was due to the keeper of the cross-head bearings being too thin. This



CAUSE OF CROSSHEAD TROUBLE AND ALTERATIONS MADE

is illustrated in Fig. 1, and it shows how the keeper was bent when the bolts were tightened up. This subjected them to a severe bending stress, and this stress, combined with the tensile stress, was too high for the bolts to withstand, so they broke.

The cross-heads were altered, as indicated in Fig. 2, the caps being made much thicker, and the nuts were also "necked," as there was no room for putting on check nuts. After being in service some time it showed that this arrangement obviated the difficulty entirely. D. K.

Harland & Wolff, Belfast, are rapidly completing the fourth largest vessel in the world for the Holland-America Line. This vessel is 740 feet long, 86 feet beam with a gross tonnage of 32,500 tons. The designed speed is 17 knots.

Review of Important Marine Articles in the Engineering Press

His Majesty's Torpedo Boat Destroyer Fury.—One of the twenty torpedo boat destroyers completed during the last fiscal year for the British Admiralty is the *Fury*. The length, breadth and depth of the hull are 240 feet, 25½ and 15 feet 7 inches, respectively. The forecastle and bridge are built high with the object of maintaining a high speed in heavy seas. Weight of hull is 310 tons and displacement on draft of 7 feet 10 inches is 770 tons. Yarrow boilers fired by oil fuel have given smokeless combustion on trial. The engines are Parsons turbines, designed for 13,500 horsepower, from which 27 knots speed was expected. On trial, however, the maximum shaft-horsepower was about 14,000, and the mean speed during the eight hours was 27.82 knots. At 13¼ knots speed, using 1,000 horsepower, the fuel consumption was such as to give a radius of action of 2,600 miles. 350 words.—*Engineering,* March 15.

Steam Trials of H. M. S. Thunderer.—The battleship *Thunderer* has successfully passed all her steam trials and is expected to be finished by her builders, the Thames Iron Works & Shipbuilding Company, by May. The length is 545 feet, beam 88½ feet and displacement tonnage 22,500 tons. The boilers are of the Babcock & Wilcox type, and the main propelling machinery consists of Parsons turbines. On the full-power trial the engines averaged 299 revolutions per minute and 27,416 shaft-horsepower, while the coal consumption was 1.78 pounds per shaft-horsepower-hour. The machinery throughout worked satisfactorily. 350 words.—*Engineering,* March 15.

The Navy Estimates.—A review of the recently-published naval estimates for the coming year for the British Admiralty. In the budget is a statement from the First Lord of the Admiralty that "These estimates have been framed on the assumption that the existing programmes of other naval Powers will not be increased. In the event of such increases it will be necessary to present supplementary estimates both for men and money." The estimates call for four large armored ships, eight light armored ships of a new type, twenty destroyers and a number of subsidiary craft. Tabulated comparisons are made throughout the paper of the budgets made in previous years with this one, and comment is favorable on the course of this year's action. 3,300 words.—*Engineering,* March 15.

The Ocean-Going Oil-Engined Ship Sembilan.—After having built the successful Diesel-engine-propelled ship *Vulcanus,* the Werkspoor Works at Amsterdam have recently completed their second vessel of this type, the *Sembilan.* She is 150 feet length on load line, 26 feet breadth and 9 feet 6 inches depth, with single screw, driven by a three-cylinder, Werkspoor Diesel marine type engine, running at 200 revolutions and developing 200 brake-horsepower. On regular voyages aggregating 1,780 miles her average speed was 7½ knots and the fuel consumption was 11.7 pounds per nautical mile. The cylinders are water-cooled but the pistons are air-cooled, both arrangements being said to work successfully. A novel feature of the engine is a patented design of cylinder whereby the piston may be examined without disconnecting piston rod or connecting rod. This is accomplished by making the cylinder with a solid head, but having a jacket bolted on the lower end, which is removed and the piston exposed for examination. The article is illustrated with drawings of general arrangement of the ship and four assembly drawings of engine. 1,300 words.—*Engineering,* March 15.

The Austro-Hungarian Battleship Tegetthoff.—Short notice and photograph of launch of the new Austrian dreadnought. Principal dimensions and specifications are: Length, 495 feet; beam, 89 feet; displacement, 20,040 tons on 26 feet draft. Machinery consists of Parsons turbines and Yarrow boilers. The vessel mounts twelve 12-inch guns and sixteen 3-inch and twenty-four smaller weapons. During the earlier stages of construction great secrecy was maintained concerning the vessel. 225 words.—*Engineering,* March 29.

Some Military Principles which Bear on Warship Design.—By Admiral Sir Reginald Custance, K. C. B. A study of naval tactics bearing on warship design, principally the subjects of gun sizes and the value of armor. The author starts with the statement that a ship of war embodies the tactical and strategical ideals of the age in which she is designed and built; that it is the business of the naval officer to examine these ideals and the military principles underlying them, and the part of the naval architect to embody these in design. He then proceeds to the examination of present-day ideals of warship construction, taking as object lessons decisive naval engagements from the time of the *Monitor* and *Merrimac* down to the Russo-Japanese War. In the study of weapons, of the three—gun, ram and torpedo—he takes time for a discussion of the gun only. The study of armor is as completely carried out. From the history of naval engagements where armor played an important part the author has derived conclusions which point to its lessened value under the latest conditions of naval fighting. As for the rest, he urges the importance of many guns and many men, even if guns of the largest sizes must be dispensed with, since, besides the moral effect, large calibers are not always effective in action. He presents tabulated data of fighting ship elements. 4,200 words.—*Engineering,* March 29.

Turning Circles.—By Prof. William Hovgaard. An investigation into the behavior of ships while turning circles under given standard conditions, which are as follows: All the ships were of the twin-screw type except one, which had four propellers. The propellers were placed in the ordinary position relative to the rudders. The rudders were of ordinary form, balanced or unbalanced. Before the rudders were laid over, both propellers were going ahead at the same speed and the valves of the engines were not touched during the trial. The rudder was laid at or near its maximum angle. An analysis of trials made upon a number of Danish warships under the supervision of Capt. A. Rasmussen, and upon a few typical vessels of the United States navy, of all sizes and types. The results are tabulated, showing sketches of forms of stern profile and rudder and giving all data bearing upon the investigation and the results which are given under terms such as radius of turning circle, speed during turning, ratio of speeds, rudder pressure, drift angle and pivoting point. The importance of this information is enhanced by the fact that this is the first contribution to this field of knowledge which gives anything like complete data on the action involved. 2,600 words. Illustrated with diagrams.—Paper read before the Institution of Naval Architects.

The Law of Comparison for Surface Friction and Eddy-Making Resistances in Fluids.—By T. E. Stanton, D. Sc. An attempted verification, by further experiment, of Mr. W. Froude's work on these topics. The work herein described is based upon the experiments and results obtained by Mr. Osborne Reynolds on the subject of friction in pipes of the flow of water. These were supplemented by experiments on the resistance of wooden models of dirigible balloons of different sizes subject to pressure of both water and wind. The coefficients of friction obtained were such as to verify the accuracy of the law of comparison for friction and eddy-making resistance. The paper is entirely theoretical in its nature and scope, and is applicable to practical use only upon

its merits as a report of laboratory experiments based upon assumptions made common to such work in hydrodynamics. 2,500 words.—Paper read before the Institution of Naval Architects.

The Salvage of the San Giorgio.—The first paper of a serial dealing with the stranding of the Italian armored cruiser *San Giorgio* on the Gaiola Shoal Aug. 12 and the subsequent salvage operations. These were quite remarkable considering the damage done the vessel and the position in which she was placed. At the time of the accident she was steaming at a speed of about 13 knots. A rocky ledge was struck amidships, and, the bottom being broken open in several places, the sea rushed into the forward and central compartments. The day following a council was held by officers in charge of the salvage, and the following plans laid down for carrying out of the work: The lightening of the ship; expulsion of the water; cutting away the reef; use of external lifting appliances. These four classes of operations were to proceed simultaneously, together with such other measures as would insure the safety of the work in case of bad weather, the prevention of extension of flooding of the vessel, and a measure of the progress of the work. For carrying out the first plan preparations were made for taking out the weights of guns, turrets, conning towers and armor. Later, the two forward funnels were sent ashore. For the purpose of expulsion of water, pumps were placed to draw from each compartment, and these were made tight as the water was rapidly removed. As several compartments were emptied and hermetically sealed, means were also provided for forcing water out of other compartments by forcing compressed air in. The article is illustrated by photographs and several very good drawings showing the condition of the bottom. 6,000 words.—*The Engineer,* April 19.

The Salvage of the San Giorgio.—Second paper. This installment deals with cutting away the rock of the reef and the use of external lifting appliances, which finally enables the ship to be floated and brought safely to a dockyard, where she has been restored to the navy. Illustrated with drawings and photographs. 3,500 words.—*The Engineer,* April 26.

The Loss of the Titanic.—By Prof. J. H. Biles. A comparison of bulkhead spacing in typical Atlantic liners with reference to the requirements of the bulkhead committee of the Board of Trade. There is presented tabulated data of spacing of bulkheads, height and strength, together with diagrams of different ships, showing placing of the same. One example is given of very effective bulkhead construction, tested by a previous accident somewhat similar to that of the *Titanic.* From that time until the present this vessel has not been equaled in that respect. Her owners have since found her arrangements unhandy and wasteful of possible passenger space, and in subsequent vessels for the same line different arrangements were made for height of bulkheads and the storage of fuel. This is a good example of how public sentiment is active immediately following a calamity, gradually becoming less acute as time passes with no immediate repetition of the horrors of such a wreck. The conclusions reached by the author are that all bulkheads should be carried as high as possible, and that the decks should be made effectively water-tight. 3,700 words.—*The Engineer,* April 19.

Load-Extension Diagrams Obtained Photographically with an Automatic Self-Contained Optical Load-Extension Indicator.—By Prof. W. E. Dalby, M. A. A description of an apparatus for taking load-extension diagrams photographically by means of mirrors. These are so adjusted that a ray of light is thrown into the field of exposure of a camera in such a manner as to be proportionate to the load upon a test specimen in a testing machine. In this way the behavior of materials at or near the yield point is plotted permanently for reference or study. With the description of the machine are given several plots showing diagrams of steel of different carbon content. Illustrated. Paper read before the Institution of Naval Architects.

Waves and Ship Form.—By Arthur R. Liddell, Charlottenburg. A consideration of waves and their effect on hull form dealing with general principles and the general characteristics of hulls for different conditions of service. Toward the last of the paper the determination of longitudinal bending moments among waves is considered, including the Smith correction applicable to wave height as communicated to the Institution of Naval Architects. A table is given for use with the Smith correction whereby the application is made easier. 3,300 words.—*The Engineer,* April 5.

The Revenue Cutter Service.—The recent recommendation to have the Revenue Cutter Service in its present form abolished has brought forth a discussion as to the work and efficiency of the service. This article states briefly its history, and makes a good case for the work done by this minor navy under the Treasury Department. Its beginning dates back to 1790, eight years before the establishment of the Navy Department, and from that time until the present the vessels of the Revenue Cutter Service have given good account of themselves in war, in the business of the Revenue Service, as savers of life and shipping property in storm and danger, and in the many commissions of miscellaneous nature that have from time to time been entrusted to their care. 2,900 words, with photographs.—*The Marine Review,* April.

The Ljungström Steam Turbine.—An article illustrated by several photographs and drawings descriptive of the type of reaction steam turbine devised and built by Mr. Birger Ljungström, an engineer at Stockholm, and his brother, Mr. Frederic Ljungström. The machine is a radial-flow reaction turbine, steam being admitted between two disks, and in its passage from their center to their circumference passing between concentric blading rings carried alternately by the two disks. The disks revolve at equal speeds in opposite directions, each disk carrying on the other end of their shafts an electric generator. The relative speeds of each set of blades is thus twice as great as in a standard reaction turbine of equal revolutions and diameter, and thus for equal efficiency the total number of blade rows is only one-quarter as great. Moreover, as there is no split cast iron casing carrying blades or dummy packings, the whole of these parts being mounted on the solid circular disks, the fear of distortion troubles is completely eliminated. This sense of security has encouraged the use of the highest degree of superheat practicable to be used. Two years ago a test machine was built of 500-kilowatt capacity, connected to water brakes instead of to electric generators. It fully realized the expectations of the designer, giving an efficiency ratio of 71.8 percent and a steam consumption of 8.75 pounds per brake-horsepower-hour with initial steam pressure of 172 pounds absolute, with 258 degrees superheat and vacuum of 28.45 inches. Since then another machine of 1,000-kilowatt capacity has been built, connected to electric generators, and is now in successful operation. 4,300 words.—*Engineering,* April 12.

Electric Ship Propulsion with Ljungström Turbo-Generators.—A communication from the inventor showing the advantages of his design of turbine for marine work. Its value for stationary work has already been proven by tests upon a 1,000-kilowatt set in practical operation. On shipboard there would be the added advantage that voltage need not be kept constant. As to efficiency of electrical transmission, 90 to 92 percent is claimed under favorable circumstances. For a 4,500-kilowatt plant running at 3,000 revolutions per minute a thermodynamic efficiency is claimed by the inventor of about 85 percent. For maneuvering, motors coupled in

cascade are recommended for slowing down to one-half or one-third speed, and for other speeds the turbine could be throttled. This system offers higher turbine and propeller efficiencies than mechanical gearing, due to the higher ratios of speeds practicable for use. A complete estimate has been made showing the saving in weight and space, fuel consumption and operating costs for the *Mauretania* using the Ljungström turbo-generators. Diagrams accompany showing relative space devoted to machinery with the present type of machinery and the estimated plant. The author gives calculations for an installation on a torpedo boat destroyer. A comparison of the performance of the Diesel engine with the Ljungström turbo-generator favors the latter, because of its slower speed for the propeller. 3,400 words.—*Engineering,* April 19.

An Analysis of the Claims of the Marine Internal Combustion Engine.—So much has been said recently upon the comparison on general principles of the marine internal-combustion motor with the steam engine that a direct comparison of estimates for specific instances may throw new light upon the matter. This has been attempted in an article under the above title in *The Engineer,* the author choosing three cases for making the test. First was chosen the small launch of about 14 horsepower used for occasional steaming; second, 80 horsepower, as used in small tugs, fishing smacks, barges, etc.; third, 1,100 horsepower as installed in small tramps. Comparative drawings of machinery space required are given for all cases, together with the figures showing costs of installation and operation and the attendant advantages of each. Besides the general statement of results the data are tabulated for convenient comparison. Briefly stated, the results are: For the smallest size the steam outfit costs much more to install but somewhat less to operate, weighs more, takes up less longitudinal space, requires more time to get under way, but is safer and perhaps more reliable. For the next size the steam engine costs about 80 percent as much to install as the other, costs more than twice as much to operate, requires practically the same space and labor attendance and more time to get under way, as was the case in the smaller boat. For the largest size considered the steam engine shows up to a larger disadvantage than in either of the others. Although its first cost is only 70 percent of an equivalent two-cycle oil engine, the fuel cost per unit operating time is more than twice as great, no allowance being made for standby losses. The steam plant will require considerably more space and a larger crew, and will run up larger repair and depreciation charges in a given time. While some items to be considered are largely matters of opinion, others may be fairly well established from experience and data now at hand. 4,700 words.—*The Engineer,* March 15.

Oil or Steam?—An editorial presenting the question of type of propulsive power. Its principal contents are comments upon the article treated in the preceding review, though in its broader aim it tries to interpret the former in its general bearing upon the whole subject. While those comparisons were made with engines to the same specifications, in practice the oil motor would have a decided advantage in running at a higher speed. This would favor economy by the resulting decrease in machinery weight. The question of which type of oil motor is most suitable for marine work is one as yet unsettled. There are good reasons why the two-cycle engine appears to be the coming type, but at the present time mechanical uncertainties delay its general adoption. In closing, the editors favor the broad and general study of the question, taking into account as most important evidence the tried results from both types and letting go as unimportant the elements non-essential or due primarily to the early state of motor development, which was productive of a great variety of types. 2,300 words.—*The Engineer,* March 15.

The Tosi Steam Turbines.—These machines are constructed by Mr. F. Tosi, of Legnano, Italy. The article here reviewed is a description of a 7,500-horsepower turbine installed in a torpedo boat destroyer for the Italian navy. It drives one of twin screws, and is of the mixed type, having six velocity-compound stages followed by a drum carrying fourteen rows of reaction blading. The first of the wheels carrying the velocity compounding blades carry four rows of blades, the others three each. In the same casing a reverse turbine is fitted, it being of the same general type, having one velocity stage of four rows of blades, followed by twelve rows of reaction blading. The turbine works from an initial pressure of 233 pounds gage down to 27-inch vacuum, developing at its maximum output 7,500 horsepower when running at 600 revolutions per minute. The astern turbine is designed to generate 3,450 horsepower at 400 revolutions per minute. Besides the marine turbine mentioned above there is shown and described in some detail a 4,500-horsepower turbine for driving an electric generator. Profusely illustrated with detail and assembly drawings and photographs. 3,400 words. —*Engineering,* April 26.

Fitted Up as Oil Burners.—An illustrated description of the conversion of the three Cramp-built steamers *Sierra, Sonoma* and *Ventura* from coal to oil burners at the Union Iron Works. The general dimensions of the ships are: 416 feet length over all, 50 feet molded beam, 28 feet 3 inches depth to main deck, displacement 9,680 tons on draft of 24 feet. The engines are triple expansion, with cylinders 28, 46 and 76 inches diameter and 48 inches stroke. The boilers are eight in number, 13 feet 6 inches diameter and 10 feet 5 inches length, with total heating surface of 14,975 square feet and total grate surface of 409.5 square feet. The changes incident to oil-burning installation include a general rearrangement of boilers and the use of one stack in place of two formerly used. 720 words.—*The Marine Review,* April.

Communication Between Engine Room and Bridge of Steamships and Some Methods of Controlling the Same.—By J. M. Newall. A complete account of the development of the engine-room telegraph, more particularly the later improvements whereby greater certainty of signals is insured. Shows type of instrument to be used with three engines or turbines, the signals being transmitted to all three by the same telegraph. Several forms of revolution and direction indicators are described and shown, among them the well-known McNab instrument. The Recordicator, an invention of the author, is described in full. This is a combination of several different instruments used on shipboard, and has for its object: to let the engineer working the engines know when he is putting them the wrong way, to signal the bridge the actual working of the engines, to record the same. The value of such an instrument is apparent. 6,500 words, illustrated with photographs.—*The Steamship,* April.

Two Hundred-Ton Electric Revolving Cantilever Crane.—There has been recently completed a very fine example of crane work for the Imperial Japanese navy by Messrs. Cowans, Sheldon & Company, Ltd. This crane, designed entirely by the manufacturers, is of 200 tons capacity, and has been tested with a load of 250 tons. Its working radii are 105 feet for 200 tons, 150 feet for 100 tons and 160 feet for 30 tons. The cantilever is supported on a square tower 50 feet on a side and rising 109 feet from quay to base of circular track. From the center of this the crane reaches out with 170 feet radius on the hoisting end and 95 feet on the motor end. The roller path is 50 feet in diameter. The motors, of which there are five 60 horsepower, one 30 and one 10 horsepower, are of the totally enclosed, series wound, multi-polar type, working on direct current at 220 volts. The crane went through a series of tests in a highly successful manner. 2,300 words and plates of structure complete.—*Engineering,* March 15.

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In referring in these columns several years ago to the possible reduction in steam consumption by the use of superheated steam we pointed out that at that time results from the use of superheated steam with turbines showed that a saving of about one percent of steam consumption could be made for each ten degrees Fahrenheit of superheat. Since then the data which have come to hand have justified this statement, as can be seen from the very complete summary of the available data from marine work in the United States which has been contributed to this issue. The data in this instance, however, include the use of superheated steam with reciprocating engines, and it is interesting to note that equally good results have been obtained from superheated steam with both reciprocating engines and steam turbines. In navy practice, where from 50 to 100 degrees superheating is commonly used, practically the same percentages of reduction in fuel and in steam consumption are obtained. At the last meeting of the Institution of Naval Architects a very interesting paper on the results of experiments with a watertube boiler, with special reference to superheating, was read by Mr. Harold E. Yarrow. His experiments included not only the installation of superheaters, but, what seems of equal importance, the utilization of waste gases for feed-water heating. His conclusions are that there will be a certain gain by the use of superheated steam of from 8 to 10 percent of fuel economy when using 100 degrees Fahrenheit superheat and from 11 to 13 percent gain when using 150 degrees Fahrenheit of superheat in combination with a pressure of 200 pounds per square inch, and also that a further gain in fuel economy can be obtained by an efficient system of heating the feed from the gases after they have passed the generator tubes of the boiler. This, he claims, can be obtained without increased weight, cost, space or upkeep of the boiler installation.

When the submarine first became recognized as an important factor in naval power its effectiveness was limited by the comparatively short range and inaccuracy of the torpedo and by the slow surface and under-water speeds of the vessel itself, its short radius of action, and its uncertain maneuvering powers. It is only about fifteen years, however, since the first practical submarine was introduced, and during that time the range of the torpedo has been increased from less than a thousand yards to about a mile. The speed of the vessel, both on the surface and when submerged, has been doubled, and the radius of action increased so that a submarine can now undertake a long sea voyage without escort. At the summer meetings of the German Society of Naval Architects, just concluded, various proposals for improved motive power for submarines were suggested, the most novel of which was the use of steam machinery in place of the present combination of oil engines and electric power, so-called soda boilers supplying steam when the vessel is submerged. Further results are needed, however, to show the superiority of this arrangement over the present type of installation.

The great courage with which every man on the engine room force of the *Titantic* faithfully performed his duty and went down with the ship has scarcely been referred to in the reports of the disaster. It seems fitting that recognition of the heroism of these martyrs should be made, and it is proposed to erect a memorial of some kind in Southampton, whence the *Titanic* sailed to her destruction.

Engineers all over the world are invited to contribute to this fund. In order to make it come within the limits of the purse of everybody, it is called a Shilling Fund (twenty-five cents), although, of course, contributions of any size will be welcome.

Any of our readers who wish to express their recognition of the great devotion to duty of these engineers can send contributions to Mr. E. J. P. Benn, Publisher, INTERNATIONAL MARINE ENGINEERING, 31 Christopher street, London, E. C., or to Mr. H. L. Aldrich, publisher of INTERNATIONAL MARINE ENGINEERING, 17 Battery place, New York.

Improved Engineering Specialties for the Marine Field

Lackawanna Arched Web Steel Sheet Piling

The characteristic feature of the new Lackawanna arched web steel sheet piling, made by the Lackawanna Steel Company, Buffalo, N. Y., is the curving or arching of the web, so that the mass of metal within the web lies to one side of the neutral axis of the section. Referring to the illustrations, the outer face of the web, or what might be termed the extrados of the arch, is flattened to lie in the same horizontal plane with the extreme outer faces of the members of the interlocked joint. In the piling wall the arches reverse with each pile with reference to the neutral axis of the wall, and the total thickness of the wall at the center of each web is equal to but not greater than the thickness of the wall at the interlocked joint. At the same time, it is claimed, the arched section transmits the load to the supports without as great a tendency to flatten out as found in corrugated sections made of rolled or bent plates.

The haunches of the arch are thickened, giving increased strength at this point against spreading, and also distributing

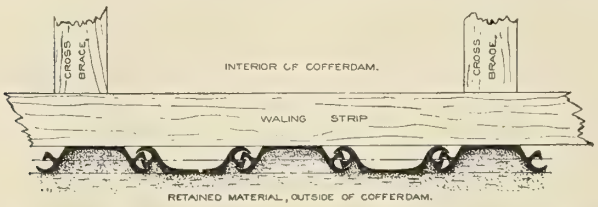


FIG. 1.—TYPICAL SECTION OF WALL OF LACKAWANNA ARCHED WEB STEEL SHEET PILING

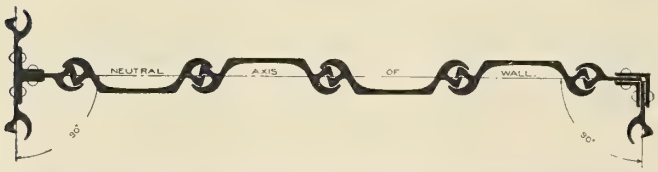


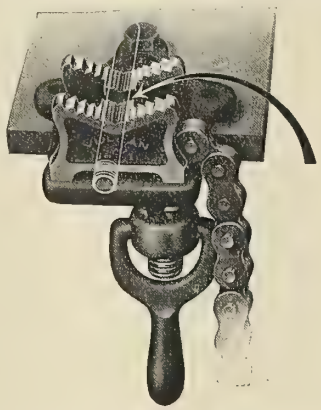
FIG. 2.—LACKAWANNA ARCHED WEB STEEL SHEET PILING ASSEMBLED

the metal in the web with reference to the neutral axis so as to increase the inertia and modulus of the section. From Fig. 1 it can be seen that on each section where pressure comes on the external part of the arch, this pressure is transmitted to the waling timber through the interlocking members of the joint. In those piles where the internal part of the arch is under pressure the pressure is transmitted directly through the metal to the waling timber throughout a wide contact. This bearing surface is greatly lengthened at each edge by the thickening of the arches at the haunches, as stated.

It is claimed that a wall of Lackawanna arched steel piling, in comparison to a similar wall of plain straight-webbed piling sections, all other conditions being the same, has much greater transverse strength, due to the higher section modulus of the individual piling sections and the correspondingly higher resistance against the bending moment produced by the peculiar distribution of the metal. This greatly increased transverse strength permits the building of a wall that is thin and compact in proportion to its lateral strength. It permits a greater vertical spacing between supports or waling timbers for piling of a given weight per square foot, therefore reducing the amount of timber required for safety under a given loading, and thus effecting economy where transverse strength is a primary consideration. Where tensional strength is of greatest importance, as in structures that cannot be braced, the ordinary straight-webbed piling will be found preferable. But for braced structures, where each pile acts as a supported vertical beam, the arched section is claimed to be relatively the strongest and most economical.

Vulcan Chain Pipe Vise

The original Vulcan chain vise manufactured by Messrs. J. H. Williams & Company, Brooklyn, N. Y., has been described in previous issues of this journal. Since this vise was introduced additional sizes have been made which will care for all pipe sizes from ⅛ to 8 inches diameter. The

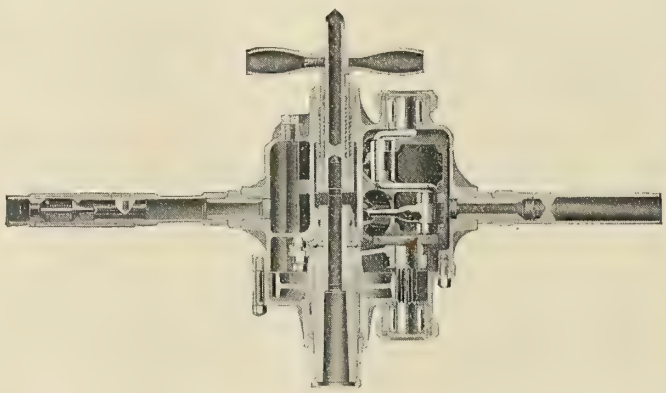


smallest size, which is termed "the baby," shown herewith, is manufactured with an added improvement, consisting of an extended tooth, which enables the extreme of chain grip without bending or injuring the smallest pipe. The vises are made entirely from wrought steel. The drop-forged jaws are of steel tempered for file sharpening.

Thor Roller Bearing Air Drills

The Independent Pneumatic Tool Company, Chicago, Ill., has recently placed a new line of portable drilling machines on the market, known as the Thor Roller Bearing Piston Air Drills.

These machines possess the same general features which were used so successfully in former types of Thor drills, such as Corliss valves, telescopic screw-feed, removable



crank chamber plate, and large air chamber. The size of the spindle in most cases has been increased, but the most radical improvement is in the crankshaft bearings, connecting rods, eccentrics and eccentric straps. The crankshaft has been greatly strengthened, and anti-friction roller bearings are provided for same. The rollers are of ample length and

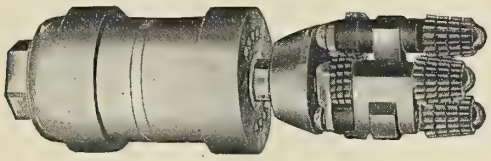
diameter and are retained in a machined brass cage. The bushings have a slip fit into the casing and are hardened and ground. The crankshaft has rounded ends and end thrust against a hardened plate, which reduces friction.

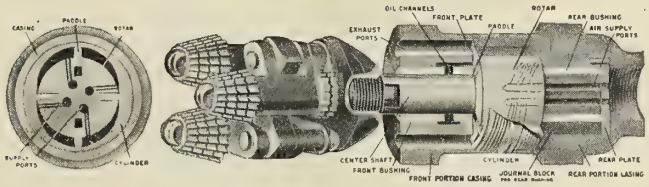
On account of the increased size of the crankshaft and ample size of rollers, the center bearing is dispensed with. The eccentric is smaller in diameter, and being mounted on the crankshaft still further reduces friction.

The toggle and connecting rod used in former types have been replaced with a one-piece connecting rod similar to that used so successfully in the Thor Nos. 8 and 9 close corner drills. Roller bearings are also provided for the idler or planet gears in the compound drills, and an improved shifter mechanism is used on all two-speed machines. The accompanying illustration shows this drill with roller bearings on each end of the crankshaft and one-piece connecting rod.

A New Type of Air-Driven Boiler Tube Cleaner

The air or steam-driven type of boiler tube cleaner has been found the most satisfactory in many power plants because water is expensive or the pressure is too low to give sufficient power to drive a water turbine cleaner. Plants in which these conditions obtain will undoubtedly be interested in a new type of air or steam-driven cleaner recently perfected by the Lagonda Manufacturing Company, Springfield, Ohio. The



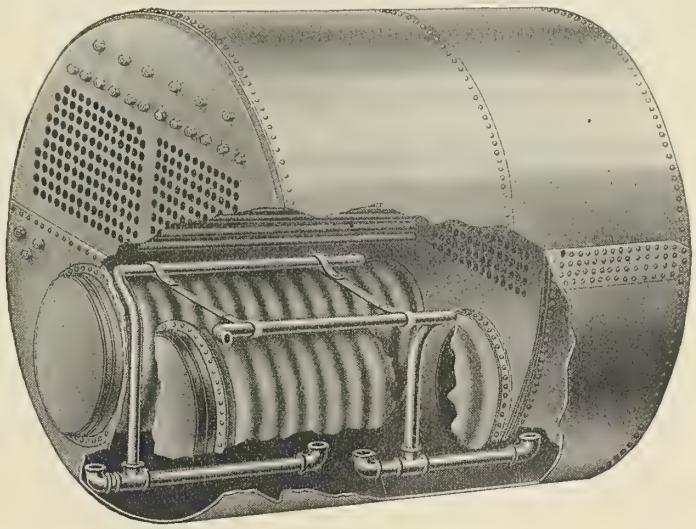


cross-sectional cuts of this cleaner, shown herewith, give a good idea as to its method of operation. As will be noted, the compressed air or steam passes through two ports in a plate in the rear end of the cleaner, then through transverse openings in the rotor, and out through branch openings to the space behind the paddles. There are only two ports opening into the air chamber, thus only the two paddles that are doing the work are under air pressure, and there is no communication to the two idle paddles, thus one of the main difficulties with other types of air-driven cleaners has been eliminated; that is, excessive leakage of air. After the air has done its work behind one of the paddles, the paddle uncovers an exhaust port, and the expanded air is allowed to pass out through the front end of the cleaner.

To permit the cleaner of operating economically under different air pressures and in different hardnesses or thickness of scale, two interchangeable rear plates are provided having different size port areas. Where there is a limited amount of air available the plate with the smaller holes can be used, thus insuring plenty of power with small amount of air. If the scale is heavy and plenty of air can be furnished the plate with larger holes can then be used and more power developed. The cleaner is furnished with either the Weinland quick repair head, or with other types manufactured by this company, and is built for cleaning tubes of 1 to 4 inches in diameter, and a special design is suitable for use in curved tubes.

Eckliff Automatic Circulator

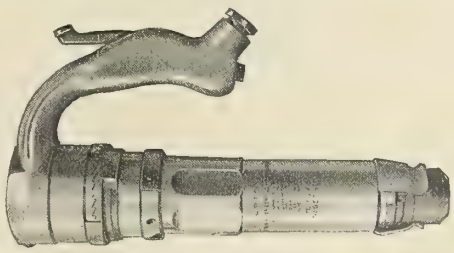
Practically the only handicap which is found in the Scotch type of boiler as a steam generator is the lack of circulation and the dead water below the grate level. To overcome this handicap the Eckliff Automatic Boiler Circulator Company, Detroit, Mich., has placed on the market a circulator which operates on the thermo-syphon principle. It is not a mechanical device but is governed entirely by the simple laws of gravitation and physics. The circulator, as shown by the illustration, consists of special tubing, so placed in the boiler that



positive heat units are absorbed from the crown sheet of the furnaces, and the circulation of the water starts as soon as a hot fire is obtained in the furnace. A blind plug, which contains a thermometer, is placed at the lowest point in the boiler, so that a glance at the thermometer will show the temperature of the water at a point in the boiler which is usually filled with dead water. With the circulator attached, however, it is claimed that a temperature of not less than 20 degrees below the temperature of the steam carried is obtained at the lowest point in the boiler, if the feed water is delivered at 125 degrees F. or better. The action of the circulator is entirely automatic; there is no wear and tear, and the only change in the ordinary construction of the Scotch boiler is to drill a single 1-inch hole in the shell to accommodate the blind plug for the thermometer.

No. 50 Boyer Hammer with Reversed Handle

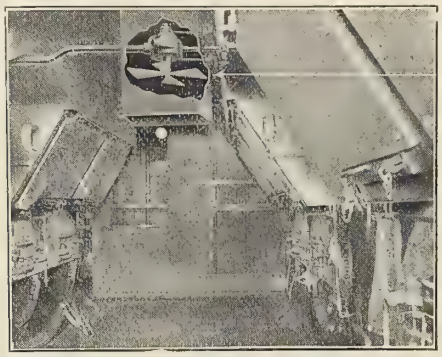
The Chicago Pneumatic Tool Company, Chicago, Ill., has placed on the market a pneumatic riveting hammer for getting into close quarters where the ordinary riveting hammer would be too long or where it could not be conveniently handled. It has a piston 1 1/16 inch diameter by 5-inch stroke; will



drive 7/8-inch rivets in structural work and 3/4-inch in steam-tight boiler work, and is 14 inches over all, including rivet set. It is particularly well adapted for driving the rivets in fire-box doors where the space is limited to about 14½ inches. In structural work this hammer is useful where the box type of girder is used.

A Practical Ventilating System

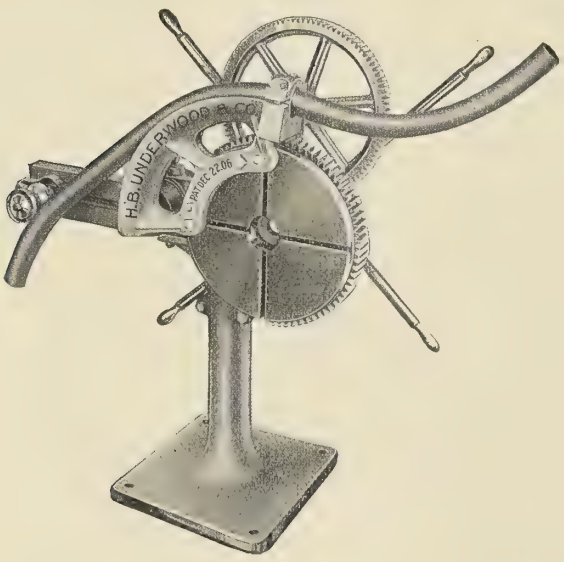
The Bryant-Bery Steam Turbine Company, Detroit, Mich., have on the market a special type of turbine designed for marine ventilating purposes. The installation can be used for the ventilation of fire rooms, engine rooms, cargo holds, galleys and living quarters. The installation is also suitable for forced draft, since it can be used either as a blower or in an exhaust system. As can be seen from the illustration, the



fan and motor form a single unit, so arranged that high temperatures do not affect its operation, permitting it to be placed directly in a stack or breeching. The construction of the turbine is such that steam is utilized, first, by impact; second, by expansion, and, third, by a patented syphon system, which, it is claimed, makes the operation of the turbine very economical. The system is furnished in various types and sizes to meet all requirements.

E and S Pipe Bending Machine

We show herewith a convenient and useful machine for bending pipes by hand which is manufactured by H. B. Underwood & Company, Eleventh and Hamilton streets, Philadelphia, Pa. The machine consists of quadrants or formers, which are mounted on a face plate which has a continuous rotary movement. A resistance stud against which the pipe rests is located on a movable arm provided with a tee



slot, permitting the stud to be placed anywhere within the radius of the arm, thus affording adaptability for any sort of pipe bending. The face plate itself is provided with four tee slots, upon which any style or shape of former or quadrant can be attached. The machine is designed for bending piping of steel, iron, brass, copper or other material up to and including 2 inches in diameter. By using special formers, light angles, flats and tee-bars can also be bent by this machine. The ratio of gearing is 25 to 1, giving a powerful leverage, so that a boy can bend 2-inch pipe. The outside dimensions of the machine, which is mounted on a telescopic stand, are: Width, 4 feet 7 inches; height, 5 feet.

The Prest-O-Welder

Welding by means of the oxy-acetylene process has firmly established itself as an important factor in the manufacture of machinery and metalware and in the reclaiming of broken castings, whether of cast iron, steel, brass, bronze or aluminum.

The Prest-O-Welder, manufactured by the Prest-O-Lite Company, Indianapolis, Ind., is a practical adaptation of this successful process to the needs of the average shop. Storage tanks of 100 cubic feet capacity are furnished for each of the gases used. This, it is claimed, eliminates the inconvenient features of the generating systems and insures safety. A supply of pure dry gas is always ready for service upon opening the valves. The whole equipment is mounted on a small steel truck, which makes the Prest-O-Welder a portable and convenient equipment for all uses. The weight of the equipment completely assembled is 300 pounds.

Welding by the oxy-acetylene process utilizes in a small, concentrated flame the heat produced by the combustion of acetylene and oxygen. The intense heat and concentration allow the recasting of the metal in the joint to be welded. As the flame is neutral the welded metal does not suffer any

injurious effects. A temperature of 6,300 degrees F. is obtained. This temperature, while more than double that required to melt any of the commercial metals, is necessary for successful welding on account of the rapid dissipation of the heat through the metal, especially where heavy material is being welded. The combustion of acetylene not only produces an extremely high temperature but also furnishes an enormous amount of heat, making possible the successful welding of the heavy materials.

The essential features of the Prest-O-Welder are an acetylene and oxygen tank, each with proper automatic reducing valves attached. The acetylene is stored in a cold-drawn, seamless steel tank, having a capacity of 100 cubic feet, and is known as dissolved acetylene, *i. e.*, acetylene dissolved in acetone in a porous filling inside the tank. The oxygen, which is to support the combustion of the acetylene, and intensify its heating power, is stored in a steel cylinder of 100 cubic feet capacity. The acetylene is led through a regulating valve, which automatically maintains a constant flow of gas. The oxygen is also controlled by a regulating valve, which can be instantly set to deliver the required amount of oxygen for the flame desired. The two gases are united in the mixing chamber of the blow-pipe. The welding heads on the blow-pipe are interchangeable and easily adapted for different sizes of material and castings.

The outfit is always ready for instant use. It needs no further attention than merely opening two valves when required. When not in use no valuable space is taken up, because the outfit is compact and easily moved about. The operation of the Prest-O-Welder is not difficult, and it is said that the ordinary workman soon becomes proficient in all its uses.

Association of Marine Draftsmen

At a recent meeting of the draftsmen of the Norfolk Navy Yard, Norfolk, Va., a permanent organization was perfected, which is to be known as the Norfolk Navy Yard Association of Marine Draftsmen. Mr. Frank H. Dewey was elected president and Mr. J. B. Sadler secretary.

This organization has for its object the promotion of the welfare of draftsmen along intellectual, social and economic lines; the establishment and maintenance of friendly relations among them in all their intercourses; the disseminating of shipbuilding and other engineering and technical knowledge; the providing of access to a wide range of technical literature; the furnishing of such records as will best serve to give the members an understanding of industrial, social and economic conditions prevailing at the various points at which draftsmen are employed, and, in general, by methods based on sound principles to develop such a standard that draftsmen, their employers and the public will cordially recognize drafting as a profession.

Similar organizations have been formed recently at a number of shipyards on the Atlantic coast, and are now being formed at the various navy yards and shipyards throughout the country, with the object in view of the formation of a National Association of Marine Draftsmen.

Personal

MR. H. C. TOWLE has been appointed chief draftsman of the merchant hull department at the New York Shipbuilding Company, Camden, N. J.

MR. THEODORE ALBERT, president of the Powell Company, died at his home in Cincinnati, Ohio, Monday, May 27.

Technical Publications

A Short Course in Graphic Statics. By William Ledyard Cathcart and J. Irvin Chaffee, A. M. Size, 5 by 7½ inches. Pages, 183. Illustrations, 58. New York, 1911: D. Van Nostrand Company. Price, $1.50 net.

Students of mechanical engineering are of necessity required to give some study to the subject of graphic statics, although the design of trusses is in general the duty of a civil engineer. Since this book is intended as a textbook for mechanical engineering students, the treatment therefore is limited mainly to the properties and general uses of the force and equilibrium polygons, a part of the subject which is usually sufficient for the solution of most of the problems which mechanical engineers are required to solve. The subject is taken up in a brief, thoroughly clear and convenient manner, and the book will prove a valuable aid to engineering students in general.

Engineering as a Vocation. By Ernest McCullough, C. E. Size, 5½ by 8 inches. Pages, 201. New York, 1911: David Williams Company. Price, $1.00 postpaid.

Nearly everyone who has devoted his life to engineering work can very easily be induced to say something on engineering as a vocation. It is not strange, however, that the average engineer would give his advice on this subject from a rather biased point of view. Opinions in this direction are probably as varied as upon any other subject of equally wide scope. There are many different branches of engineering, and each offers special advantages as a vocation, but all engineering work has this in common: that it requires certain cardinal qualities in the type of man who is capable of making a success of it. This is well set forth by the author in this book. He also proceeds to set forth some ideas about the chances for great success and the demand for engineers that are very much at variance with the commonly accepted ideas of the public. His knowledge, however, is based upon a long career of splendid achievement and cannot be accepted as far from the truth. It will well repay anyone who is contemplating taking up engineering as a vocation to read this book and inquire into the conditions which he suggests.

Marine Engineering Estimates and Costs. B. C. R. Bruce. Size, 4¾ by 7 inches. Pages, 126. Glasgow, 1911: Fraser, Asher & Company, Ltd. Price 4s. 6d.

No engineer can be considered to have mastered his profession until he has become thoroughly familiar with its commercial side. In such large establishments as shipyards the technical and commercial departments are always separated by a more or less hard-and-fast line, and sometimes both the technical man and the commercial man come to sword's points. Where the commercial end of the work is placed entirely in the hands of a department which is separated from the technical or engineering work, there are apt to be misunderstandings, and much better harmony can be obtained in the management of such an establishment if each department becomes more familiar with the work of the other. The point where these two departments have most in common is in the making up of estimates for new work and the cost accounting of machinery passing through the shops. The author of this book, therefore, has undertaken a most useful task in setting forth rather briefly the general principles under which such work is done. The book is not an explanation of the practice of any one concern, but is applicable to almost any shipyard or engine works. First are considered the inquiry and specification; then the agreement or contract; the division of work between machinery and hull, and a standard estimate. For this some very valuable information is given on estimating weights and labor charges for the construction of engines and boilers, also the computation of establishment charges. A chapter is devoted to the determining of approximate machinery sizes, and several chapters to different cost

accounting system. Finally, a chapter is devoted to the relative costs of different types of marine propelling machinery and the trend of development in marine propulsion. The book has every reason for commendation, and it is only to be regretted that the work was not carried on further.

Maximum Production in Machine Shop and Foundry. By C. E. Knoeppel. Size, 5 by 7½ inches. Pages, 365. Illustrations, 34. New York, 1911: *The Engineering Magazine.* Price, $2.

Most of the subject matter presented in this book is based on three series of articles published recently in *The Engineering Magazine.* When the matter was arranged in book form, however, it was largely recast and rearranged in order to present the subject in a well balanced and well proportioned form from beginning to end. The author of the book is a man whose work has been intimately connected with current practice on the foundry floor and in the machine shop, so that he is thoroughly familiar with shop conditions and workmen. He has, further, been under the influence of and received training from one of the foremost efficiency engineers, so that the book was shaped by very wide experience and sound judgment. The machine shop and foundry are considered as twin factors in production, one of which is as important as the other, and, since they are so closely related, many of the principles of organization and management tending to efficient operation and maximum success are common to both. The differences in the two are carefully brought out, and the whole gives a valuable insight into what is probably the most important modern metal industry.

Marine and Naval Boilers. By Lieut.-Com. Frank Lyon, U. S. N., and Lieut.-Com. A. W. Hinds, U. S. N. Size, 5¾ by 9¼ inches. Pages, 450. Illustrations, 112. Annapolis, Md., 1912. United States Naval Institute. Price, $3.50 postpaid.

Designed as a textbook for use at the United States Naval Academy, this book has been based upon a previous text-book on steam boilers by Capt. F. C. Bieg, U. S. N., which has been used at the Academy since 1903. Recent advances in boiler construction and management, however, required a new treatment of the subject, and, owing to the death of Capt. Bieg, the work of revising the former textbook was undertaken by the authors of the present volume. Unlike most standard textbooks on steam boilers, very little consideration is given to the subject of boiler design, calculation of strength and methods of manufacture. A great deal of attention is given, however, to the description of details of various types of watertube boilers, which are commonly used in naval vessels, together with most of the boiler accessories. The subjects of heat and heat transfer, combustion, fuel and firing of boilers are carefully considered, and the parts given to liquid fuel and methods of firing liquid fuel are of particular value to naval men, since oil-fired boilers are becoming more general in naval service every year. Most of the descriptive matter is supplemented by excellent illustrations, which are reproduced on a large scale from detail drawings.

Practical Thermodynamics. By Prof. Forrest E. Cardullo, M. E. Size, 6 by 9 inches. Pages, 411. Illustrations, 224. New York, 1911: McGraw-Hill Book Company. Price, $3.50 net.

The author of this book has presented the subject of thermodynamics from the physical rather than from the mathematical standpoint, so that common sense rather than a knowledge of higher mathematics is the guide for the reader. Thermodynamics is always looked upon by students in technical schools as a very difficult subject, because the principles are hard to understand at first sight, and the whole work is usually wrapped up in such extensive mathematical details, expressed in new forms of phraseology, that the main points are somewhat obscure. In this work, however, the subject is taken up in a manner somewhat different from the usual textbook. In the first place, it is as simple as it would seem possible to make such a work, and then the order in which the points are made lead the reader to grasp the principles and understand the phenomena of heat engines and other thermodynamic machinery in their proper sequence. The fundamental physical principles upon which further study of the subject must depend are given in the first seven chapters. Then follow the application of these principles to the various types of engines and machinery. Each chapter is followed by a number of carefully chosen problems, the solution of which is useful in suggesting the application of principles rather than for bringing out the student's knowledge of the subject matter in the chapter. The book is a valuable addition to the field of practical engineering literature.

Lloyd's Register of American Yachts, 1912. Edited by W. P. Stephens. Size, 9 by 7 inches. Pages, 502. 46 illustrated plates. New York, 1912: Lloyd's Register of Shipping. Price, blue cloth, gilt edges, $8.50; plain canvas, $7.00

Lloyd's Register of American Yachts may now be considered a permanent institution in yachting, having reached its tenth volume and attained a size proportionate to the great growth of the sport since the general adoption of the marine gas engine. Replacing the older registers once known to sailing yachtsmen, the book follows the same general lines, but differs in the far larger number of power craft and the extra detail required for their proper description.

The total number of yachts registered this year is 3,533, about 60 percent of these being in the power division of the fleet; large steam yachts, auxiliaries, small and large, and gasoline (petrol) cruisers of all sizes; the relative decrease of the sailing yacht being more rapid each year. The changes from last year are, for the most part, made up of the dropping of a number of the older sailing yachts, both small and large, and the addition of several sizes of gasoline (petrol) cruisers, notably the handy and convenient little raised-deck launch of 28 to 35 feet length, and the cruiser of 75 to 100 feet. The additions to the sailing division of the fleet are comparatively unimportant, and the conversion of sailing yachts to auxiliaries which went on so rapidly several years ago is less marked, for the reason that most of the outclassed sailing yachts have been already converted, and the older ones, dating from the early Burgess era, about 1885, are being sold for fishing or for breaking up.

One of the favorable signs of yachting is the steady growth in popularity of the cruising launch, largely of the raised-deck type, in all parts of the country; the users of these craft being recruited alike from the ranks of the old sailing yachtsmen and from the newcomers in yachting. This class of yacht is rapidly outnumbering all others in the old yachting centers of the Atlantic coast; it is making new converts to yachting on the Western lakes and rivers; it is represented in larger numbers each year in Florida and other Southern waters; while Puget Sound can boast of a large fleet of very fine cruisers, nearly all of recent construction.

The burgees of these clubs, to the number of nearly 500, make up thirteen handsome color plates, and two more plates are devoted to the National ensigns, the International Signal Code and the Weather Bureau signals. The private signals of yachtsmen, to the number of nearly 2,000, are also given in colors, while the list of owners contains the names and addresses, to the number of 3,350, of the owners of all yachts entered in the Register with the clubs of which he is a member, the yachts he owns and the number of his private signal. One important feature of the Register which has been considerably extended this year is the American Trade Directory, a complete list of all the arts and industries connected with yachting, forming a guide for the yachtsman in the purchase of every class of yachting requisite.

Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

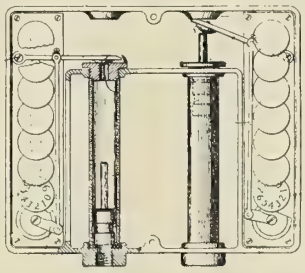
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,010,568. FLOAT FOR DREDGES. HARRY J. BARNHART AND HARVEY T. GRACELY, OF MARION, OHIO, ASSIGNORS TO THE MARION STEAM SHOVEL COMPANY, OF MARION, OHIO, A CORPORATION OF OHIO.

Claim 1.—In a dredge the combination, with a hull and a float, of a brace loosely connected to said hull and normally movable relatively thereto, said brace being disconnected from said float and arranged to extend over the latter to retain the same in position and adapted to be moved away from the float to permit the float to be removed. Six claims.

1,010,662. REGISTERING AND INDICATING APPARATUS. ALEXANDER McNAB, OF NEW LONDON, CONN., ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE McNAB COMPANY, OF BRIDGEPORT, CONN., A CORPORATION OF CONNECTICUT.

Claim 1.—An apparatus for indicating and registering the number of revolutions of a shaft, comprising an air tight casing, an agitator driven positively with a motor, indicator tubes wiithin said casing and communicating therewith, freely movable plungers within said tubes and having pin extensions, registering mechanisms compising a train of



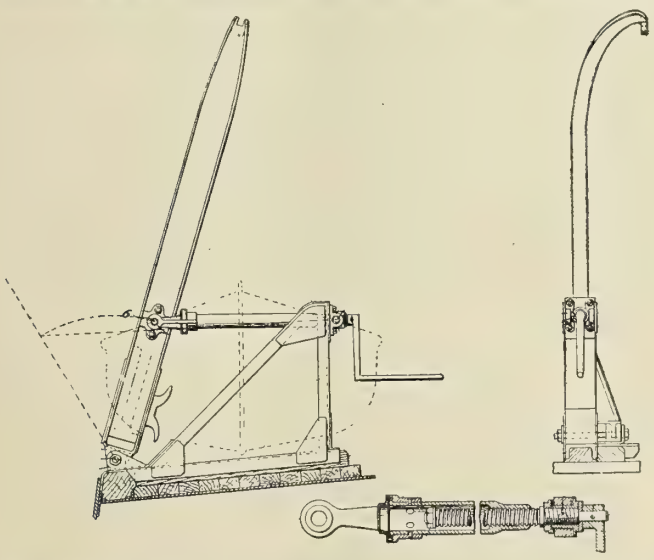
sequentially connected counters, levers pivoted within said casing and normally within the path of said extensions, and operative connections between said levers and registering mechanisms whereby the impacts and withdrawals of said extensions will throw said levers and allow them to return to normal positions and thereby effect the operation of said registering mechanisms. One claim.

1,010,767. LOADING AND TRIMMING MECHANISM FOR BOATS. GEORGE H. HULETT, OF CLEVELAND, OHIO, ASSIGNOR TO THE WELLMAN-SEAVER-MORGAN COMPANY, OF CLEVELAND, OHIO.

Claim 1.—In a machine the combination with a depending tubular member and a laterally projecting chute at the lower end thereof, of a tilting housing pivotally supported by said depending member and supporting said chute. Twenty claims.

1,011,477. BOAT-DAVIT. HAROLD F. NORTON, OF NEWPORT NEWS, VA.

Claim 1.—A davit supported by a pivot at its lower end, and means for oscillating said davit, comprising two substantially horizontal members connected by a nut and long screw, one member being non-revoluble



and directly swiveled to said davit intermediate its ends, the other member being revoluble, and a fixed deck-stool having a swiveled bearing in which said revoluble member is journaled, its outer end extending through the bearing and carrying a crank. Three claims.

1,013,024. METHOD OF AND APPARATUS FOR CONSTRUCTING HULLS OF VESSELS. SIMON LAKE, OF MILFORD, CONN.

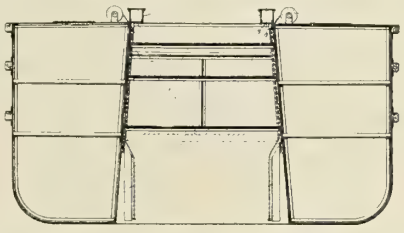
Claim 1.—The method of constructing hulls of vessels, which consists in properly locating the ribs of the hull, then arranging a portion of the plates forming the skin of the hull in position over the ribs and welding them to said ribs and end to end to each other throughout practically the entire length of the hull, and finally arranging the remaining plates in position and welding them to said ribs and welding their abutting ends to each other and their longitudinal edges to the abutting edges of the plates first welded in position. Six claims.

1,018,050. SUBAQUEOUS ROCK-BREAKER. ALEXANDER W. HASSELL, OF JERSEY CITY, N. J., ASSIGNOR, BY MESNE ASSIGNMENTS, OF ONE-HALF TO HASL-COE CONSTRUCTION COMPANY, A CORPORATION OF NEW YORK.

Claim 3.—In a device of the class described in combination, lifting means, a crusher bar, and a gripping device; said gripping device including means for engaging the crusher bar, and means for automatic ally disengaging the crusher bar from the gripping device when the crusher bar is raised to a predetermined point; and means for limiting the downward movement of the gripping device. Seven claims.

1,018,565. SCOW FOR TRANSPORTING GRAVEL AND THE LIKE. THOMAS C. JACKSON, OF CHICAGO, ILLINOIS, ASSIGNOR OF ONE-THIRD TO ROSE J. A. SHANKS, OF CHICAGO, ILLINOIS.

Claim 2.—A scow having a compartment which is open at its top and at its bottom, a plurality of superposed supporting and separating



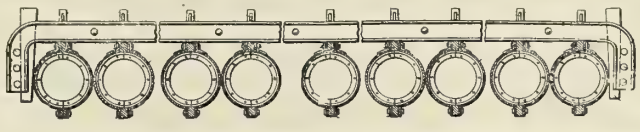
screens for material extending across the compartment and supported on the side walls thereof, the mesh of the upper screen being larger than the mesh of the lower screen. Fourten claims.

1,018,848. CLAM-SHELL DREDGER. SAMUEL CHARLES SMITH, OF DAISY, LOUISIANA.

Claim 1.—In combination, a frame, a rotatable nut vertically mounted in the frame and provided with a beveled gear at one end and having its other end held against movement upwardly and downwardly, a vertical screw extending through said nut and having threaded engagement therewith, shafts supported in the frame at right angles to said screw, drums on said shafts each provided with a beveled gear meshing with the gear carried by the nut, oppositely wound suspended cables respectively attached to said drums, scoops pivotally attached to the lower end of said screw and means for pivotally suspending them from the frame. One claim.

1,019,224. RAFT FOR DREDGES. HORACE J. CLARK, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE CLARK DREDGE MANUFACTURING COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF MAINE.

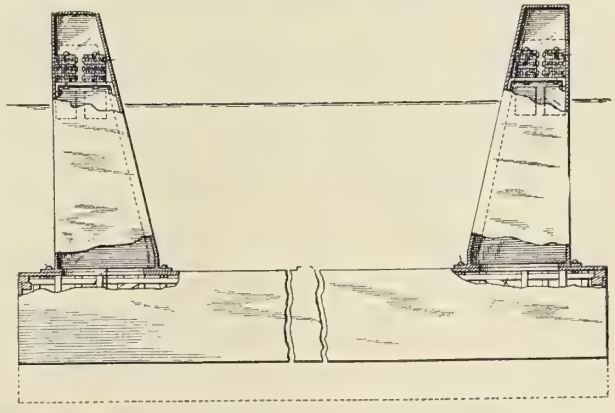
Claim 1.—A raft of the kind described comprising a plurality of floats, each float being formed of a plurality of sections bolted together, beams



carrying means for holding said floats in their proper relation, and straps and keys for connecting said floats to said beams. Eighteen claims.

1,019,434. FLOATING DRY-DOCK. WILLIAM THOMAS DONELLY, OF BROOKLYN, N. Y.

Claim 1.—In a floating dry dock, heavy solid buoyant means formed of wood and located in the top of the wings normally above the water line thereof at approximately the greatest degree of submergence of the



dock, when under control and thereby normally acting as ballast and adapted, when control of the dock is lost, to be thereby automatically submerged and caused to act as buoyancy and prevent the dock from being entirely submerged. Two claims.

1,019,437. SCREW-PROPELLER. CLARE H. DRAPER, OF HOPEDALE, MASSACHUSETTS, ASSIGNOR TO C. F. ROPER, COMPANY, OF HOPEDALE, MASSACHUSETTS, A FIRM.

Claim 2.—A propeller blade whose working surface has generating lines

increasing in curvature from the leading to the following edge, said generating lines being tangent to radii at the periphery of the hub and forward of such radii throughout their length. Three claims.

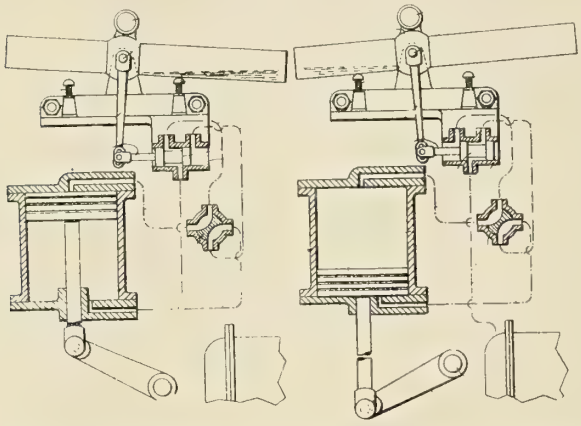
1,019,226. HATCH-FASTENER. WILLIAM CRAIGIE, OF GODERICH, ONTARIO, CANADA, ASSIGNOR OF ONE-SIXTH TO WILLIAM MARLTON AND ONE-SIXTH TO WILLIAM WALLACE, BOTH OF GODERICH, CANADA.

Claim 1.—The combination with the hatch cover, coaming and tarpaulin, of a bracket arm secured to the coaming, a hook-shaped clamp pivoted to one side of the bracket arm having a suitable upper end designed to hook over the edge of the hatch cover, a cam having a suitable recess therein to receive the end of an operating lever, said cam being pivoted to the bracket arm and engaging the hook-shaped clamp, a batten for holding the canvas in place and a supplemental cam pivoted to the opposite side of the bracket arm to the aforesaid cam and engaging the batten, said supplemental cam having a recess therein to receive the end of the operating lever. One claim.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

29,078. MARINE ENGINE GOVERNORS. T. JACKSON, NEW CROSS, AND A. RAMSAY, FOLKESTONE.

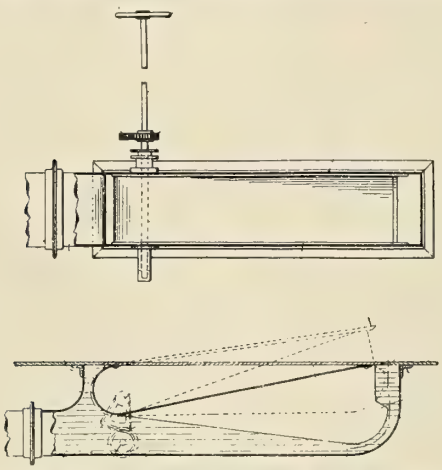
This invention relates to governors in which a gravity controlled device is utilized to control the operation of mechanism for actuating the throttle valve. The first figure shows the instrument adjusted for head seas, the head of the ship being to the left. When the vessel pitches



the mercury in the tube flows to the left suddenly and the tube rests on the other stop, as in the second figure. Air can then enter through governor valve and reversing valve to the top of the cylinder, the piston of which operates the throttle. Simultaneously the lower end of the cylinder is opened to the vacuum of the condenser.

18,633. SHIPSIDE SEA WATER VALVE OR INTAKE. J. HALLIDAY. LIVERPOOL.

By this invention the intake of water is automatically effected when the valve is opened. A casing is bolted over an orifice cut in the forward part of the ship's side, on the flat back from the bow, and has a rearward outlet. The outer side is provided with a hinged door, the



hinge at the rear, the door opening outwardly from the ship's side and closing flush with it. The spindle of the hinge by which the door is controlled when operated by hand, has a geared sector engaging a spur wheel carried by an operating shaft fitted with a hand wheel. In this way a rapid supply of water may be obtained for any purpose.

135. PROPULSION OF SHIPS AND THE LIKE. F. JENSEN, COPENHAGEN.

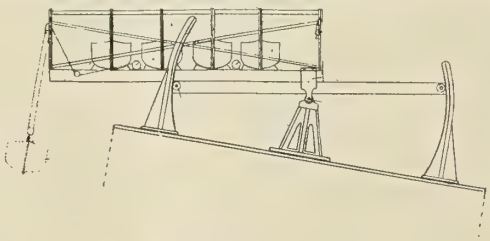
By this method the ship is propelled and steered by suction and pressure devices, the distinguishing feature being that the suction pipes, which are directed towards the fore part of the ship, emerge through the stern-half of the ship's bottom and the pressure pipes, which are directed towards the stern, emerge through the fore-half of the ship's bottom, and are so arranged that the position of the ship in relation to the horizontal and in part also the speed of the ship are thereby determined.

13,349. SHIP PROPELLER. GEORG ARTHUR SCHLOTTER, OF DRESDEN, GERMANY, ASSIGNOR TO SCHLOTTER-PROPELLER-PATENTVERWERTUNGS-GESELLSCHAFT MIT BESCHRANKTER HAFTUNG, OF DRESDEN, GERMANY.

Claim 1.—A propeller comprising helicoidal blades the surface of which is formed by the movement of a generatrix composed of a straight line of constant length whose end-points move on an outer and inner cylinder concentric with the axis of the propeller, said generatrix being tangential with the inner cylinder and forming with a radius drawn from its outer end-point to the propeller axis an angle which is equal to the angle of pitch of the blades. Five claims.

18,402. STOWING AND LOWERING AND RAISING SHIPS' BOATS. W. J. GREENFIELD, WATERFORD.

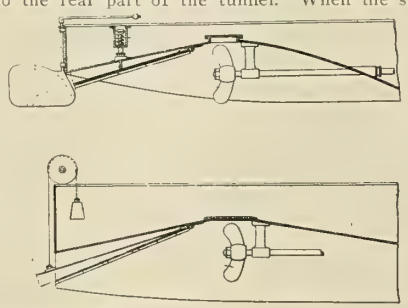
Claim.—The apparatus comprises a platform provided with a railway and placed athwartship on the ship's deck and free to be rocked on trunnions to port or to starboard. Side members carry a cage having



rails and trolleys from which the boats are suspended, and the side members and cage of boats can be caused to travel to port or to starboard on the platform so that the boats may be raised or lowered by tackle.

28,726. PROPELLER CHAMBERS OR TUNNELS FOR SHALLOW-DRAFT VESSELS. A. F. YARROW, BLANFIELD, N. B.

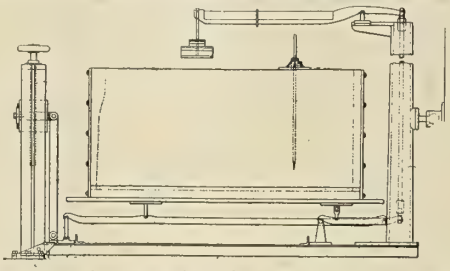
Claim.—Shallow-draft vessels when propelled by screws mounted in tunnels above the water level are provided with a flap adapted to form a false roof to the rear part of the tunnel. When the ship is at rest



these flaps rest upon air-tight ledges. In running forward the expelled water raises the flap, which is balanced by a spring or weight, so that no power is wasted in forcing the water below the level. In going astern the flap remains on its ledges and prevents access of air to allow the fall of the water level.

15,832. MEANS FOR ASCERTAINING THE WEIGHT OF A SHIP AT ANY TIME WHEN AFLOAT. W. H. WILLIAMS, R. I. M. S. "NORTHBROOK."

Claim.—This invention consists in the use of a measuring shell model, so constructed that it may be filed with some of the water in which the ship floats and whose volume will be in proportion to the volume displaced by that portion of the ship above a predetermined line. By weighing the volume of water in the model and translating the weight of the



representative water into actual weight of displacement the weight of the ship is ascertained. A proportionate mould of the exterior of the ship between horizontal planes at or near the light and deep load lines respectively is used and means for indicating the immersion above the lower plane. The shell model stands on a weighing platform, so that on filling the shell with water to a depth shown by a gage to correspond with the actual immersion of the vessel beyond the lower plane the weight of water actually displaced by the portion of the ship above this plane can be ascertained. This weighing machine is carried on a platform that can be leveled fore and aft and 'thwartship, and the platform fixed so that the axes of the shell and ship are parallel.

26,134. SHIP'S SOUNDING APPARATUS. A. I. GARCIA, NAVAL CAPTAIN, LONDON. (A COMMUNICATION FROM J. I. GARCIA, NAVY OFFICER, BUENOS AIRES.)

Claim—This is an apparatus in which a feeler bar is mounted so that it may turn horizontally and vertically near the center of the keel with which it is held normally parallel by a chain wound on a drum. When in use the bar is lowered until it makes an angle of 55 degress with the keel. Should the ship run over ground less than 30 feet below the surface the bar is raised and allows a light rod to rise correspondingly and indicate on a scale the depth of water below the keel. A sliding contact rests above the rod and may be set for any depth indicated by the bar, so that when the rod touches the contact an electric alarm is rung.